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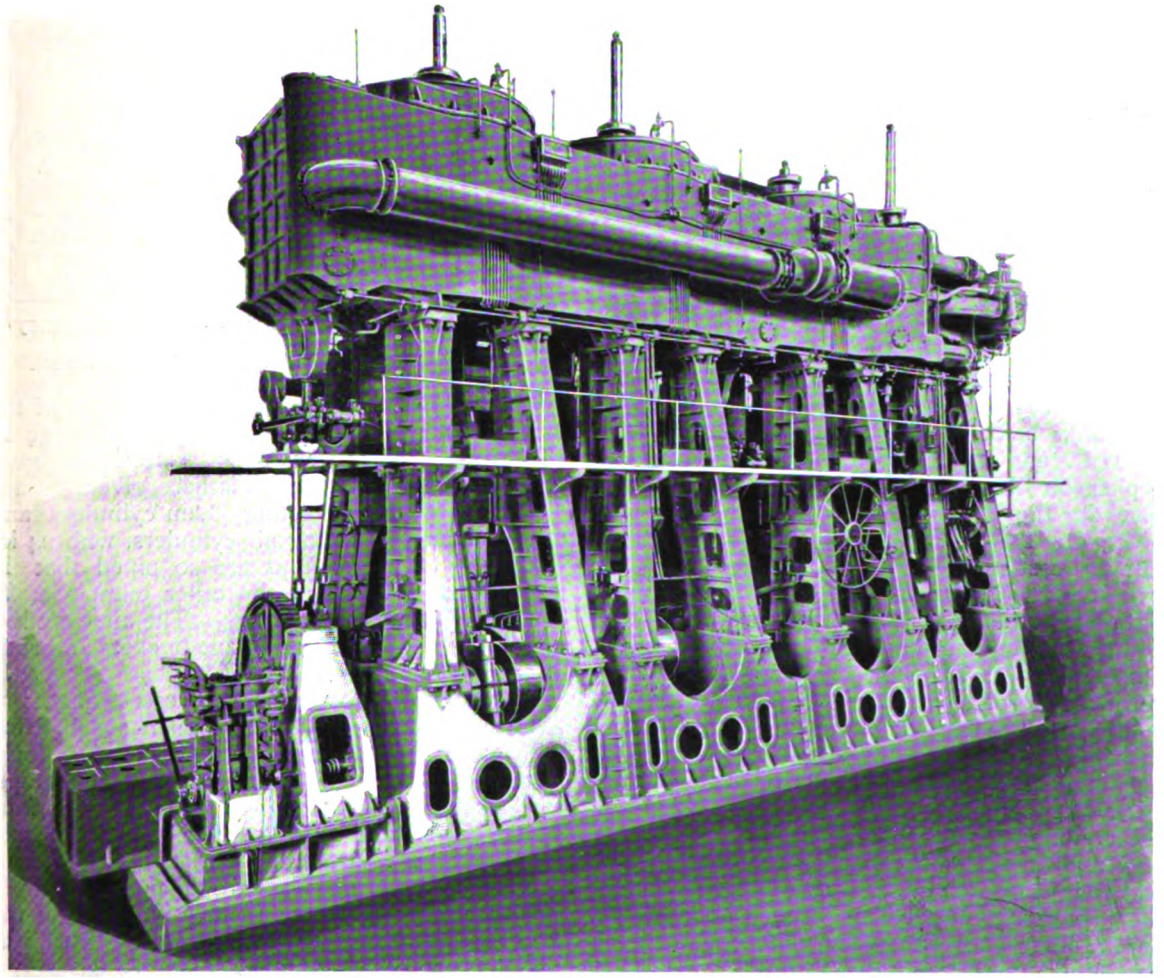
TRANSATLANTIC RECORD BREAKER KAISER WILHELM DER GROSSE.

Two transatlantic records were smashed when the new North German Lloyd liner Kaiser Wilhelm der Grosse reached the port of New York, September 26, after a passage of 5 days, 22 hours and 45 minutes, from Southampton. The distance covered was 3,050 knots and the average hourly speed 21.39 knots, which not only establishes a new record on the route, but excelled the maiden trip record, not only for this, but every other route to America. The daily runs were 208, 531, 495, 512, 554, 564 and 186 knots.

This immense vessel, now the largest afloat, is 648 ft. long over all, 66 ft. beam and 43 ft. deep. Her tonnage is 14,000 and displacement 19,684 tons. Until such time as the White Star liner Oceanic, now building at Belfast, is put into the water the Kaiser Wilhelm der Grosse can claim undisputed title to being the largest, and probably fastest, liner afloat. The trip



FOUR CYLINDER, TRIPLE-EXPANSION ENGINES, T. S. S. KAISER WILHELM DER GROSSE.

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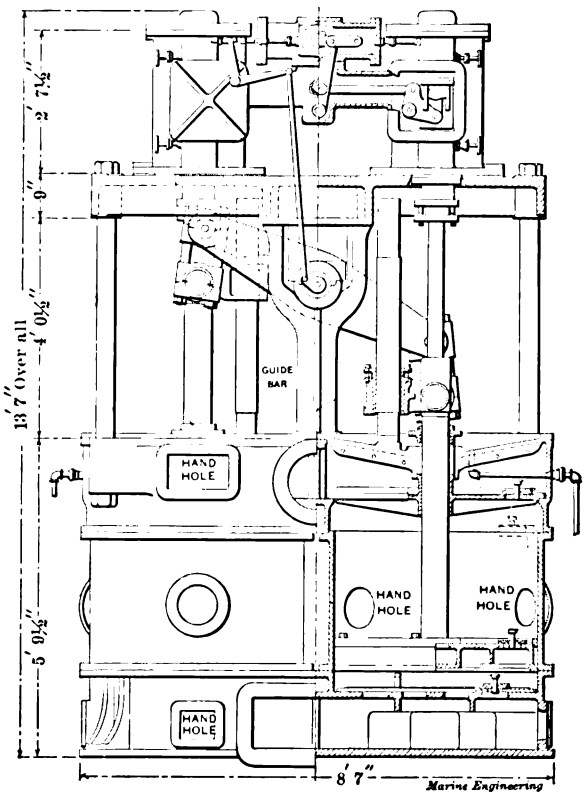
across was also the trial trip, as, owing to low water in the Baltic, she was not sent to sea before the regular day of sailing with a full passenger list. This makes her performance all the more remarkable, as there was no possibility of making any readjustments or special preparations for the trip across, such as would have been possible had a trial trip shown where they were necessary. It will be noticed that the longest day's run was 564 knots, or two knots more than the Lucania's best run of 562 knots. The highest speed attained during the voyage was a fraction less than 23 knots, or rather less than the Lucania showed on her trial trip, when a maximum speed of 23.25 knots was attained by the Cunarder.

As will be noticed in the photographic reproduction of the builders' model, the new vessel is built for speed, with wonderfully fine lines. Her machinery is just as well adapted to the production of speed. The main engines are of very symmetrical design, with not a pound of material wastefully used. They are used solely for driving the ship, all the power needed for auxiliaries being supplied by independent machinery, according to the best modern practice. The vessel is built of mild steel, with a double bottom divided into 22 subdivisions, extending the entire length along the keel line. The hull is also divided into 18 water-tight compartments by 16 transverse bulkheads, extending to the upper deck, and one longitudinal bulkhead in the engine room. The main engines driving the twin screws are of the four cylinder, four crank, triple expansion, vertical type, with cylinders 52 in., 89.75 in. and two 96.5 in. dia. and 68.9 in. stroke. They are balanced on Schlick's system, the cranks being spaced 100 deg. apart, except the H.P. and I.P., which are 60 deg. apart. Stephenson link motion is used, with piston valves for the H.P. and I.P. cylinders, and slide valves for the L.P. The columns and bed plate are cast steel, the former of the girder pattern, giving a very rigid frame with light weight, as shown in the engraving. At 77 revolutions a minute the engines are designed to develop 28,000 horse power. The crank and line shafts are of nickel steel, made by Krupp at the Essen foundry. The tensile strength is 88,580 lbs. Each crank shaft is built up, in four sections, each 11.45 ft. long. The shafts in journals and pins are 23.62 in. dia., with 9.45 in. axial holes. The coupling disks are 40.9 in. dia. and 6.3 in. thick and are held together by 14 bolts. The total weight of each crank shaft is about 81 tons. The propeller shafts are 24 in. dia. and 198 ft. long. Three-bladed propellers are fitted, 22 ft. 3.75 in. dia., with a pitch of 32 ft. 10 in. They are made of bronze and each weighs 26 tons. The propeller shafts are carried inboard and the propeller blades overlap slightly, though not to the same extent as in the White Star fliers. The condensers for the main engines contain 11,060 tubes, and have a cooling surface of 35,522 sq. ft.

There is a very complete installation of auxiliaries. In case of damage to the hull, there is a combination of centrifugal and reciprocating pumps available, which can throw 3,600 tons of



BLAKE AIR PUMPS, KAISER W. DER GROSSE.

water an hour. The main air pumps are of the vertical twin beam type, built by the George F. Blake Mfg. Co., of New York. A sectional drawing of one of these pumps is here given. Each has two 8 in. double acting steam cylinders and two 44 in. single acting air cylinders, with 24 in. stroke. The two pumps are so piped that in case of one giving out the other pump can be connected to both condensers. The air cylinders are composition lined, and have buckets and rods also of composition.

The boiler equipment of the vessel consists of twelve double-ended Scotch boilers, each fitted with eight furnaces and two double ended, four-furnace boilers. They are arranged in groups, each group connected with one of the four smoke pipes, and each contained in a separate water-tight compartment, so that in case of collision the supply of steam would not be entirely cut off. The stacks are 12 ft. 2 in. dia. and the tops are 106 ft. above the keel line. Steam at 185 lbs. pressure is carried.

There is an extensive electric light plant supplying current to 1,600 incandescent lights of 25 C.P. each. Altogether there are 68 engines aboard the ship, with 124 steam cylinders.

Cabin passenger accommodations on this vessel are really magnificent, not only in the point of

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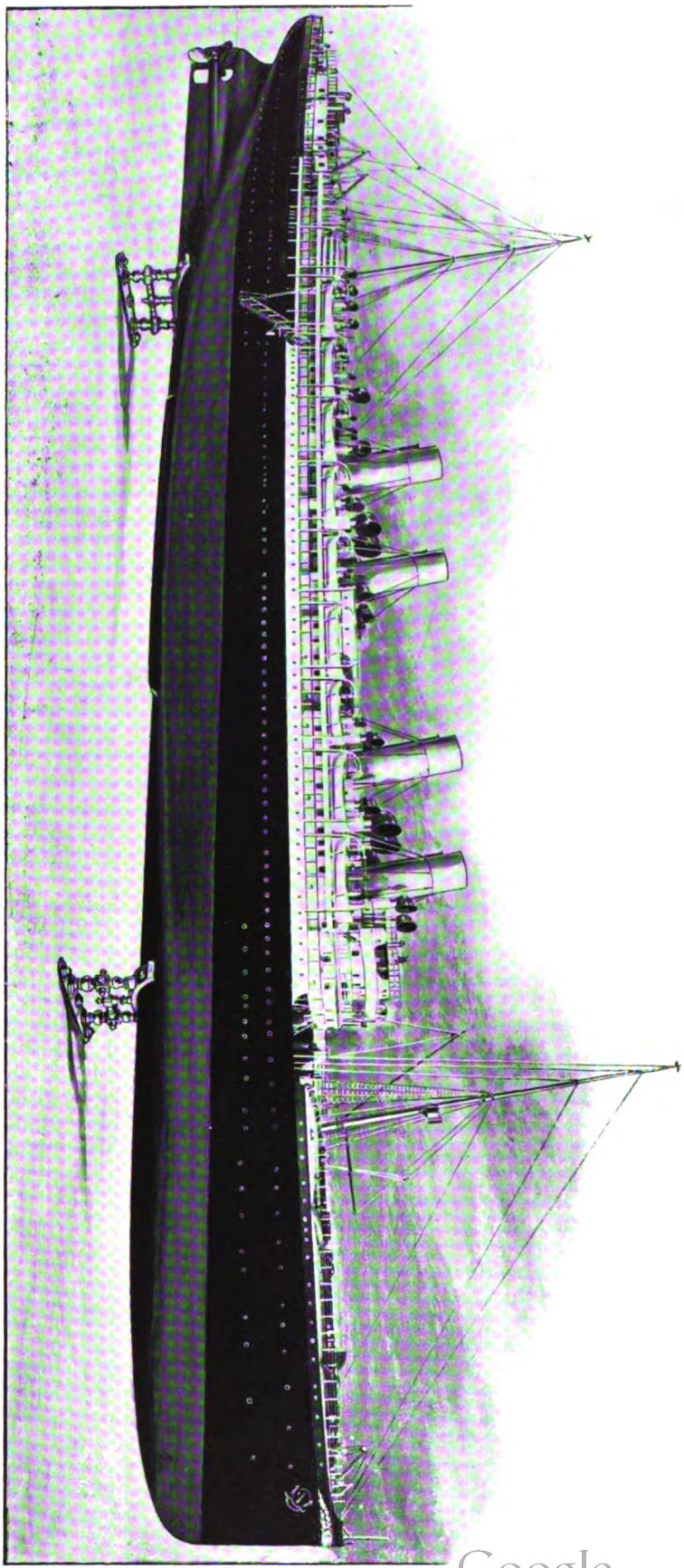
decoration, but in spaciousness and convenience. This care has, however, been expended alike in the designing of the accommodations for the passengers of other classes and for the crew. The steerage passengers have been placed in the forward part of the vessel, entirely separated from the amidship portion, which is occupied by the first-cabin passengers, who in their turn are separated from the after part of the vessel, in which the second-cabin passengers are placed. The crew again have their allotted space in the immediate neighborhood of their working stations.

Instead of open gangways on both sides of the upper deck exposed to the weather, such as are on other passenger steamers, the designer, in arranging the upper deck construction, placed the rooms on the upper deck at the sides, the gangways running on the inner side of the rooms. On the older express steamers of the North German Lloyd the space for officers and the engine force is placed in the amidship portion of the deck house, on the upper deck, whereas on the Kaiser Wilhelm der Grosse this space is entirely devoted to rooms for first-cabin passengers. The first-cabin rooms are nearly all placed upon the upper and promenade decks, so passengers are berthed on the upper decks, where no bulkheads hinder the ventilation. This permits, also, of easy access from one part of the vessel to another, and at the same time the rooms being situated high above the water, the port holes can be kept open in almost any weather. The large dining room is situated amidships on the main deck, between the two sets of smoke stacks. On the upper deck above the dining room are the majority of rooms for first-cabin passengers, and on the promenade deck, which is the deck above the upper deck, the drawing room, library and



BUILDERS' MODEL OF THE NORTH GERMAN LLOYD TWIN SCREW EXPRESS STEAMSHIP KAISER WILHELM DER GROSSE.

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the smoking room are placed, together with a number of very attractive cabines de luxe and special staterooms. Three staircases lead from the promenade deck to the lower decks. The principal staircase leads into the large dining room, which takes up the entire breadth of the ship, and in which 350 persons can dine at once. On each side of the dining room there are three alcoves, and in the middle of the room is a large skylight. At both ends of the large dining room there are on each side four smaller dining rooms for small parties. A novelty is a vestibule on the upper deck above the dining room, which can be used in bad weather, and from which a view of the dining room can be had. On the promenade deck above this space is the drawing room. This will be the central gathering place for music and social entertainment. The most attractive feature of this drawing room is a large painting, life size, of Emperor William I. On both sides wide gangways lead from the drawing room to the smoking room and to the library.

The library, situated forward of the drawing room, contains a large assortment of international literature in bookcases and is provided with easy chairs, sofas and writing tables.

Four cabines de luxe on the promenade deck are situated on the corridor, from the drawing room to the library, and consist each of a very attractive sitting room, a large bedroom with a brass bed and luxurious bathroom.

There are for the use of the first-cabin passengers 200 staterooms, offering accommodations for 350 passengers, and of these rooms a number are arranged for one person only. The long promenade deck is 400 ft. in length, protected by an awning deck.

The second-cabin passengers are placed aft of the engine room and are accommodated in about 100 rooms, in which 370 persons can be berthed. The second-cabin dining room, extending from side to side of the vessel, is situated on the main deck, immediately aft of the engine hatch. Toilet and bath rooms for cabin passengers of both classes are particularly well arranged. Besides the four bathrooms belonging to the cabines de luxe, there are fourteen large bathrooms for first-cabin passengers distributed throughout the steamer. The second-cabin passengers have six bathrooms.

The steerage passengers are accommodated in the forward part of the vessel in two compartments of the main deck and four compartments of the lower deck, and 800 steerage passengers can be accommodated.

The crew, numbering 450, is very comfortably berthed. The captain's and officers' cabins are on the awning deck close to the bridge. The engineers and firemen are placed on the main deck and lower deck adjoining the engine room, and can reach their work in any weather without inconvenience. The cook's contingent lives near the kitchens, and the stewards of the first cabin are placed amidships and of the second cabin aft. The seamen have their rooms in the forward part of the main deck.

The provision rooms for cabin passengers are amidships aft of the engine room, and those for the steerage passengers forward. Provisions are hoisted from the former by an electric elevator to the first and second cabin kitchens, situated immediately above. These kitchens are furnished with large white porcelain ranges and tiled floors.

The second-cabin kitchen and the rooms for two large bake ovens are on the upper deck, between the engine and boiler hatches. The provision room in the forward part of the vessel contains a cellar cooled by ice, and the kitchen for the steerage passengers is situated above the provision room under the forecastle and is provided with five boilers for steam cooking. The drinking water is kept partly in iron tanks and partly in the double bottom. Three hundred tons of drinking water can be carried, which are pumped into two large collecting tanks on the awning deck, from which the water is distributed by means of pipes into every part of the vessel. The cargo, baggage and provisions are worked through six hatches with four steam winches.

The navigating appliances for the vessel are, of course, of the most improved types. The steering gear is by Brown Bros., of Edinburgh, and is on the orlop deck under the water line. It is operated from the navigating bridge by hydraulic power, the usual hand wheel being fitted. The main bridge is situated above the deck house on the awning deck and contains a large pilot house and chart room. There is also a bridge aft with connecting telegraphs to the main bridge. The steamer is supplied with Hall's stockless anchors.

This grand ocean liner was built by the Vulcan Shipbuilding Co., at Stettin, under the requirements of the German Lloyd's and of the Imperial Navy. In war time she would be fitted with rapid-fire guns and sail as a cruiser under the German flag. She was launched May 4 last. Another vessel of this type, the Kaiser Friedrich, is building for this company at Schichau's yard at Dantzic. She will be somewhat smaller than the Kaiser Wilhelm der Grosse, but will have high speed also.

Dimensions.	St. Paul.	Lucania.	Kaiser W. der Grosse.	Gr. Eastern.
Length over all	554	620	648	697
Length between perpendiculars	535	601	625	680
Beam	63	65.2	66	82.6
Depth	50.4	43	43	58
Draught	—	—	26	30
Gross tonnage	11,629	12,952	14,000	18,915
Horse power	20,000	30,000	28 000	7,652

COMPARATIVE TABLE OF DIMENSIONS.

For assistance received in the preparation of this article we have pleasure in acknowledging the courtesy of Gustav Schwab, of the North German Lloyd Co. in New York.

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PITTSBURG AND CINCINNATI PACKET LINE STERN WHEEL STEAMER QUEEN CITY.

BY BERT L. BALDWIN, M.E.

The early settlers in the Western States were not long in discovering that the large rivers formed the "great natural waterways," which could be used most advantageously in the transportation of all heavy goods and supplies to the various settlements that were being located along the river banks. At first the primitive raft was used for this purpose; then came the flat boat, which, with gradual improvements, developed the type of boat which is still in use upon many of the smaller streams, being poled or pushed up stream and floated with the current down stream. The early river men quickly appreciated the value of steam as a power that could be utilized to advantage in handling their boats, as the first river steamer, the Orleans, was launched at Pittsburg during the year 1811; or about four years after Fulton had launched his first steamer, the Clermont, on the Hudson, and proved that it was possible to make the steamboat a commercial success. On the Northern lakes, the Sound and on the Eastern rivers, where the depth of water is practically uniform, where there is little or no current and a wide channel that can be utilized when steering and turning, the finely modeled keel-bottom boats can be used, to the exclusion of almost all other types. In the Western rivers, however, where at certain seasons of the year the current is swift and the channel narrow and tortuous, these keel-bottom boats, if of any size, would be of little use, while the shallow-draught, flat-bottom boats can be handled over sunken sandbars and snags as well as around sharp bends in a manner that would surprise many salt-water pilots. The pilot on a river steamer utilizes the current almost as much as he does the engines in making sharp turns, clearing snags, bridge piers, and in making landings. The most popular boat on the river is the stern wheeler, a most distinctively American type of craft, built to surmount more difficulties of navigation than are ever encountered by deep-water craft. They may look queer to an old "salt," who is sure to call them "wheelbarrows," but they have been gradually developed so as to meet the various conditions and requirements demanded in the river service; and the very fact that many of the best known firms in England, France and Germany are building stern-wheel boats for shallow river navigation, after having tried side wheels and special propellers, shows that the American "wheelbarrow boat" has proved to be all that has been claimed for it. So successful indeed has been this type of boat for shallow river navigation that it is used on all rivers, and is scattered over the world from the Volga, in Russia, to the Magdalena, in South America. On the latter river, so successful have been the American-built boats, that our builders have the preference over all competitors and a practical monopoly of the construction.

The most modern boat that floats upon the Ohio or Mississippi river is the stern-wheel steamer Queen City, which was launched from the ways of the Cincinnati Marine Railway Co. at Cincinnati, June 5 last. This steamer was built expressly for freight and passenger service on the Ohio River, between Pittsburg and Cincinnati.

The Pittsburg & Cincinnati Packet Line, which owns this steamer, has added to its fleet from time to time, and the construction and equipment of each new steamer have been a decided improvement upon the previous ones, so that the steamer Queen City represents the very latest improvements in Western river practice. The company's superintendent, Capt. J. F. Ellison, under whose personal supervision the boat was built and equipped, says, modestly, that there is not a single detail which is actually new, but as far as possible everything has been made strictly up to date, and the good points of many boats have been combined in this one. So this article, which is intended for the many who are not familiar with the river steamer, will describe the steamer Queen City as she is to-day, a representative of the best Western river practice.

The illustration on page 7 shows the steamer complete as she appears on the river, drawn up at the foot of the ways upon which she was built, while the drawings in the supplement in this issue show the steamer in outline only. These drawings have been prepared to show the principal systems of framing and bracing, as well as to show the manner in which the machinery is distributed, it being very important to have the various loads so located that the boat will ride upon a level keel when empty.

The hull is 235 ft. long between perpendiculars, with a breadth of beam of 44 ft. at gunwales, 42 ft. beam at floor of hull and 51 ft. over guards. The half cross section A (see supplement) is taken just forward of the boilers, while cross section B is taken aft of the engine-room bulkhead. The enlarged cross section of hull and boiler deck framing (see supplement) shows more clearly the general arrangement and names by reference to the accompanying table of the various timbers and framing. At the midship section the hold is 5 ft. in depth at the knuckles, with the main deck crowning 10 in. to center. The hull has a shear of 4 ft. 6 in., which increases the head room in the hold, as well as adds very materially to the appearance of the entire vessel. About 60 ft. of the forward portion of the hull, known as the forebody, is modeled to as fine lines as possible, taking into consideration the very shallow depth of the hull as compared with its breadth of beam. The framing and general construction of this forebody are practically the same as would be found in any well-built, keel-bottom, wooden vessel that was designed for deep water, and is finished with a sharp stem, which is protected by

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a heavy wrought-iron stem band. The main keelson is extended and framed into a massive stem frame, while the moulded frames are shaped to correspond to carefully laid out water lines, and stiffened by the various strakes and keelsons which are carried throughout the entire length of the hull, these longitudinal members having long scarf joints well bolted together. In the bow there are three systems of timber framing, forming massive breast hooks which stiffen the bow so that it is able to resist all of the various strains that may occur in making landing, encountering heavy drift wood, floating ice, shoving barges, grounding upon and sparring over sandbars, which makes it important that this portion of the hull shall be just as strong and rigid as possible. The moulded frames and floor beams are made of clear oak 4 1-2 in. by 5 in. on forebody, 4 in. by 5 in. on dead flats to midship, and 3 1-2 in. by 5 in., aft of this point. They are spaced from 10 in. to 14 in. from center to center, according to location. On the dead flats the floor beams lap 8 ft. on each side of the main keelson, thus doubling the floor beams for a width of 16 ft. through the center of the hull, where the greatest loads and strains are to be resisted. The main and bilge keelsons are let into the flood beams 1 in. and secured with heavy drift bolts properly forelocked. All strakes and clamps are made of Oregon fir, and double bolted on the floor.

By examining the enlarged section of the hull it will be seen that on top of the main keelsons, extending from the breast hooks to the stern planking, is a bulkhead formed of three thicknesses of 1 1-2 in. thick tongue and grooved dressed lumber, the center thickness being made of yellow poplar and run fore and aft, while the outside thicknesses are of yellow pine laid vertically, all thoroughly fastened in place with a top strake made of two thicknesses of 3 in. by 9 in. oak, and with 3 in. by 3 in. side stanchions lapped on main keelson and thoroughly screwed and bolted as well as being further stiffened by a system of double truss rods, forming a veritable backbone for the entire structure.

The forebody is covered on the outside with 4 in. thick selected oak, while the planks under the double floor beams on dead flats are 3 in. thick, and those on either side of this portion of bottom 3 1-2 in. thick. The grub and saddle strakes are also made of oak, while the straight sides, aft of the forebody, are planked with Oregon fir, 3 in. thick, up to the four-foot water line and 2 1-2 in. thick above this point. All seams are thoroughly filled and caulked with hemp payed with red lead, after which the entire forebody and the side planking near the stern are covered with No. 12 wrought iron for the better protection of the planking. The knuckles throughout the entire length of hull are covered with 1-8 in. thick iron, secured by countersunk spikes.

Extending almost the entire length and on each side of the hull is a system of timbers which are known as the hog chain footlines, made out of two thicknesses of 10 in. by 10 in. white pine laid with break joints, scarfed and bolted at joints. These footlines are let into the floor beams 1 in., and bolted through the bottom every 4 ft.

The main deck framing consists of Oregon fir deck beams, supported by the central bulkhead and the various rows of stanchions with their beam strakes. These beams vary in dimensions, being 5 in. by 5 1-2 in. from the stem to forward hatch, where the heaviest freight is handled; 3 1-2 in. by 5 in. from forward hatch to within 40 ft. of main transom and 3 in. by 5 in. aft to the main transom.

The moulded outrigger beams on forebody, which support the overhang of the main deck, are 5 in. by 5 1-2 in. in size, while the remainder of the outriggers are 3 in. by 8 in. in the throat, projecting 3 ft. 6 in. beyond the gunwales, and carrying the guard planks and nosing; the nosing being protected against abrasion by two lines of 1-4 in. by 3 in. wrought iron, with butt strap joints and secured by countersunk spikes.

As will be noticed, the guards extend with a very heavy overhang well toward the stem frame and form a semicircular bow, which space is utilized by the capstan, and is also necessary for the proper handling of the landing stage.

The deck beams and outriggers are covered with a deck of selected stock white pine 2 1-2 in. thick, excepting the portion which comes under the boilers and coal box, where there are longitudinal strips spaced about 18 in. on centers, which carries a 3-16 in. thick steel deck, having butt plates on underside with countersunk rivets at all joints, and an angle iron rim extending entirely around the outer edge, forming one large drip pan, which is properly drained at the low corners. This steel deck is secured in place by suitable wrought iron stirrup bolts, passing under each deck beam. Below this steel deck, and located where they will be most beneficial, are two built-up boiler beams formed of 3-8 in. thick steel web plates stiffened on both sides, top and bottom, by 3 1-2 in. by 5 in. by 1-2 in. steel angles, all properly riveted together. These beams extend from gunwale to gunwale, being straight upon the bottom surface and crowning to the center, where they are 18 1-2 in. in depth. As their name implies, they are intended to carry the weight of the boilers with their furnace settings as well as the weight of the chimneys.

A very important detail in the hull construction is the system of hog chains, which are intended to prevent the steamer from breaking in two in case it grounds centrally upon a snag or sandbar. This bracing is much lighter in weight than the heavy hog frames, which are used upon lake and sound steamers, being in this case simple 10 in. by 10 in. selected white pine braces properly seated on and secured to the footlines, which distribute the strain over a very large area of floor surface. The hog chains are made of refined

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PITTSBURG & CINCINNATI PACKET LINE STERN WHEEL STEAMER QUEEN CITY.

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wrought iron, 2 in. diam., with solid forged eyes where they are secured to the brace cap castings, anchored securely to the breast hooks in the bow and to the engine timbers and hull at the stern, as indicated on the profile of the steamer.

By examining the cross section of the hull it will be noticed there are diagonal braces with truss rods, shown in dotted lines. These are located under the engine room, where they add greatly to the stiffness of the hull without materially interfering with the handling and storage of freight. The diagonal braces, which are shown in full lines, running from the bilge keelson to the beam strake, are located opposite the central stanchions aft of boilers on main deck, and react against the strain set up by the knuckle chains, which are intended to transfer the strain produced by the weight of freight that may be loaded upon the guards to the central portion of the hull.

Along the strakes and floor beams are 1 1-4 in. white pine boards secured to suitable battens, and laid in sections so that they can be removed without breakage when necessary. This movable floor, or dunnage, extends from the breast hooks to rake of stern, and forms a level surface for the handling and storing of freight. Between the floor and deck of hull there are systems of very heavy strakes, stanchions and diagonal truss rods, forming heavy trusses for supporting the engine timbers as well as resisting the various strains set up by the engines and wheel when in service.

What might be considered a part of the hull construction are the engine timbers, which form the bed plates for the engine as well as project beyond the stern and form the support for the stern wheel. As the name implies, these members are usually made of wood, which has always been a source of trouble on account of shrinking and twisting, making it difficult to keep the cylinders, guides and bearings in proper alignment, as well as to prevent their sliding and slipping while in service, so that in the present steamer these "timbers" were built up in steel, in accordance with modern practice. Each of these engine timbers consists of two built-up box girders with 3-8 in. steel web plates, 3-8 in. by 10 in. top and bottom plates, which are heavily reenforced over the main transom, and have 3 in. by 5 in. by 1-2 in. steel angles at all corners, the two girders being secured to each other by a number of built-up spreaders, arranged so as not to interfere with the working parts of the engine. The outside girder extends a few feet beyond the after end of engine slide plate, while the inner girder projects about 30 ft. or more beyond the stern line, carrying the pillow block and supporting an extension of the guards for the protection of the wheel, as well as forming a very convenient platform for the examination and care of the main bearing and cam. These steel girders are secured in position by heavy foundation rods which extend through the bottom of the hull and are properly forelocked. The overhanging portions are further stiffened by the systems of hog chains and braces, shown on the drawing.

At the stern will be seen the rudder casings, which are arranged to accommodate the rudders, of which there are four of the partially balanced type. The central rudders are known as the main rudders, while the outer ones are the wing rudders. These rudders are massive in construction, with flitch stocks 12 in. by 14 in., having steel plates on the sides extending the full length of the stocks, and each has three sets of rudder irons made of phosphor bronze and secured by heavy strap bolts passing around the stocks and stern posts. The tillers are built up of two thicknesses of oak, size 3 1-2 in. by 12 in., bolted together with distance pieces between and secured to stocks by heavy side strap bolts. The main tillers are about 17 ft. long, while the wing rudders have tillers 8 ft. long. The tillers are all coupled together inboard, while the rudders are also coupled by heavy wrought-iron couplings beyond the rake of the stern. The main tillers have small truck wheels on their under side, centrally located, which run upon semicircular guide tracks supported by framework, known as the elevated circles, which are shown on the deck plan.

On the main deck will be found a central row of stanchions which are also arranged so as to form a truss system, adding greatly to the stiffness of the hull. This is shown clearly upon the profile of the steamer, which was specially drawn to show the various systems of framing and bracing, the cabin and guard stanchions being omitted in this elevation so as to not complicate the drawing. The main deck is divided into certain compartments by the various bulkheads shown. Forward of the boilers will be noticed the main coal box, the front of which is made of 1 1-2 in. tongued and grooved yellow pine, extending up to the boiler deck, although 3 ft. of the upper portion is hinged in such a manner as to drop and allow a free circulation of air to the furnaces when needed. The sides of coal box are only carried to a height of 6 ft. above the main deck. There are bulkheads along the sides of the furnaces, which are hinged for convenience in making repairs. These coal boxes are lined with oak to a height of 5 ft. above the deck. Aft of the boilers the fore and aft bulkheads are carried up solid to within about 30 in. of the boiler deck, and this space is closed by sliding glazed sash in the engine room and by lattice work in the deck room. The other bulkheads are carried up solid to the boiler deck with such window and door openings as are necessary, and all made of tongued and grooved white pine stiffened between stanchions by dressed pine studding and girts which are not more than 1 3-4 in. by 3 1-2 in. in dimensions.

The splash bulkhead at the stern is made of 1 1-2 in. thick white pine tongued and grooved and put together with white lead joints. On the starboard guards, forward of the engine room, is located the cook house, while opposite this, on the

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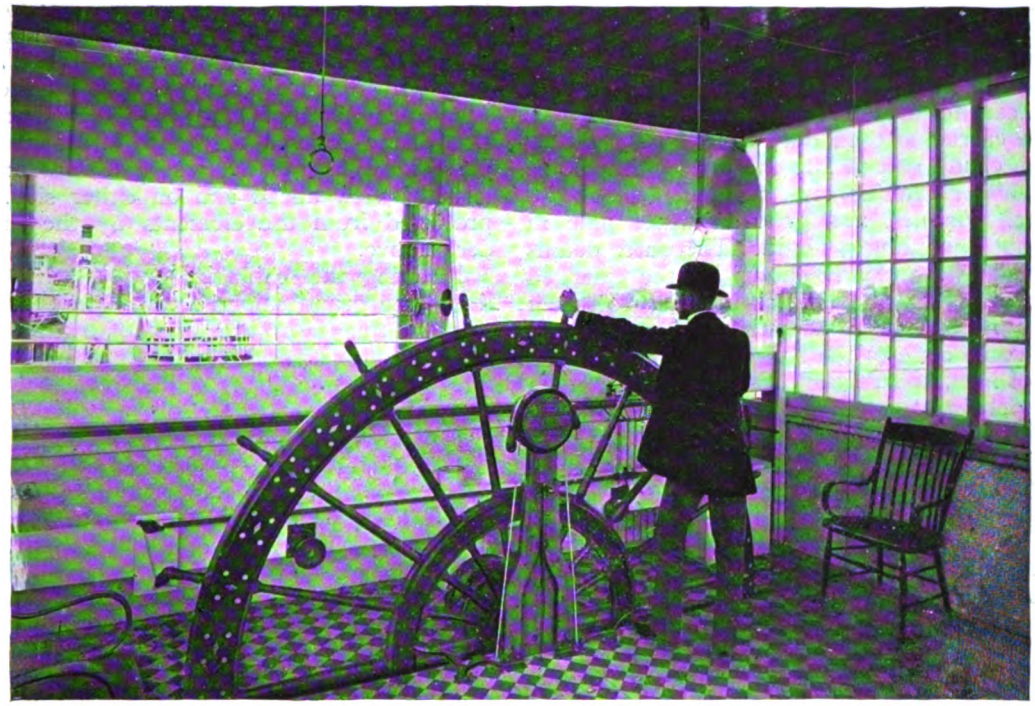
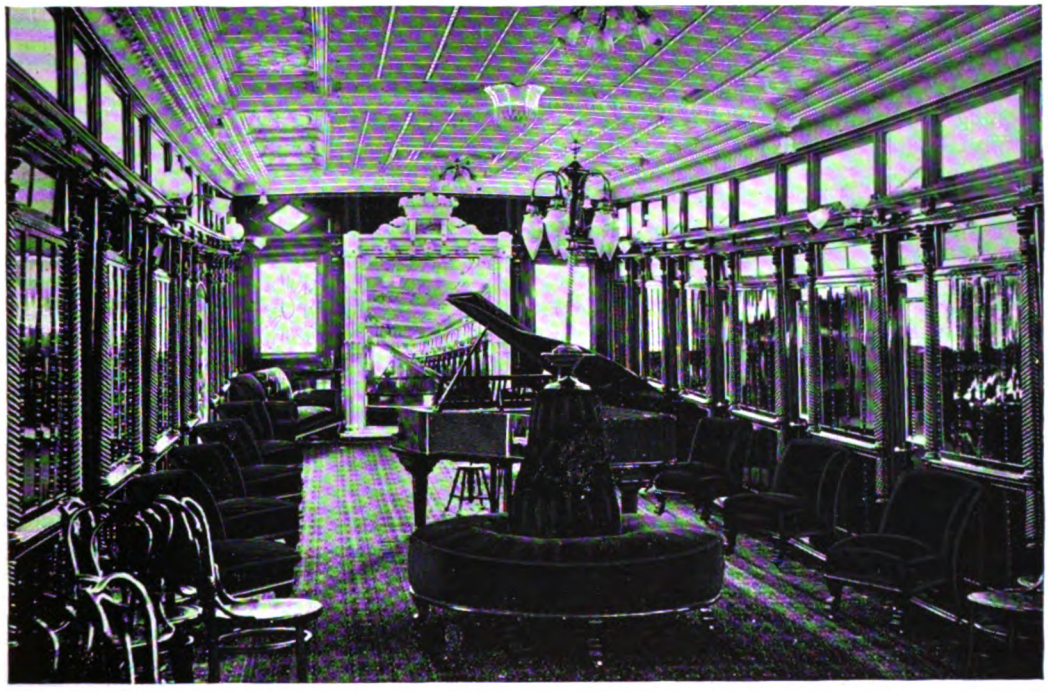


INTERIOR OF PILOT HOUSE OF STEAMER QUEEN CITY.

port guards, is a toilet room, both of which have stairs leading to the boiler deck.

The central line of stanchions, above the main deck, support a continuous white pine ridge pole with scarfed joints 8 ft. long, bolted together with 1-4 in. by 8 in. wrought-iron side plates at these joints, and further stiffened by truss rods and braces where the span between stanchions makes



LADIES' CABIN IN OHIO RIVER STEAMER QUEEN CITY.

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this necessary. The forward stanchions are 8 in. by 8 in. at the deck and 8 in. by 6 in. at the cap. The side cabin stanchions are 4 in. by 6 in. at bottom and 4 in. by 4 in. at top.

The carlines are 2 in. by 6 in. dressed poplar, and are carried at their outer ends by a 1 1-2 in. by 9 in. clamp gained into the guard stanchions.

The boiler deck consists of selected stock 7-8 in. thick tongued and grooved white pine in width not exceeding 3 1-2 in. The outer details of this deck are clearly shown by the enlarged section of hull and boiler deck framing, so that it is only necessary to add that the stanchions which come close to the boilers and furnaces are made of iron, and that all exposed corners upon the hog chain braces and stanchions are protected by 1 in. by 1 in. by 1-8 in. single angle iron, carried to a height of 5 ft. above the main deck and properly secured by wood screws.

The guard stanchions, or as they are sometimes called stationary fenders, project above the boiler deck level, and the swinging fenders are made fast to them at this point with 1-4 dia. galvanized wire lashings.

The foregoing describes the portion of the steamer's hull and framing, which differs considerably from deep-water practice. The remainder of the framing, which goes toward forming the cabin, texas and pilot house, is very similar to the usual steamer practice, unless it is that the entire structure is designed so as to be just as light in weight as possible, all parts being placed and tied together in such a manner as to obtain an extraordinary amount of strength considering the small amount of material which enters into its construction. To build a steamer of the size of the Queen City, with a top hamper rising three tiers high above the main deck and only draw 32 in. of water in running order, but without freight, requires the greatest care, skill and experience in proportioning and placing these various parts so as to obtain the desired results.

It is not necessary to enter into a detailed description of the framing of cabin, texas and pilot house, although the dimensions of a few of the members may be of interest, such as the lumber in cabin bulkheads, consisting of 5-16 in. thick white pine; the guard stanchions on upper decks only 1 3-4 in. by 1 3-4 in. oak, and the state room carlines of 1 1-2 in. by 3 in. yellow pine.

A very noticeable feature in this steamer, and one which will meet the approval of nearly every marine architect, is the comparatively small amount of scroll-saw ornamentation used in the vessel, which usually adds to the cost of maintenance as well as to the fire risk. The various guard rails, which are generally composed of light fancy woodwork, are in the present instance made entirely of a heavy galvanized wire netting, having double wires arranged in a diamond mesh measuring 5 in., its greatest dimension, and secured to the base and hand rails.

A very substantial hard-wood stairway leads from the main to the boiler deck, having moulded and polished hand rails on either side and around the well opening, supported by ornamental turned balusters and massive newel posts. The stair tread are completely covered with polished sheet brass. These stairs land upon the forward portion of the boiler deck, which forms an inviting place for the voyager, where he has an unobstructed view ahead and on either side, and is protected from the elements by the hurricane deck above.

Entering the cabin by one of the forward doors the grand saloon extends from the cabin circle to the stern, a distance of 200 ft., without an obstruction, excepting the furniture, to interfere with the view. As one critic has said in discussing this steamer, "up to this point the Queen City can be compared to a number of large steamers that have been built for service on Western rivers, but when you once pass the door of the grand saloon all comparisons must stop. You find before you not a Western steamboat cabin, but a saloon that, taken in detail, will compare most favorably with the finest on lake, sound or even ocean going steamers."

In place of the usual zinc white woodwork the bulkheads, or side walls, are finished in mahogany, with twisted columns, having deeply carved plinths and urn-shaped capitals, forming the jambs of each stateroom door, with carved architraves, mouldings and friezes, all finished in the natural color of the wood and brought up to a high polish with the same care as is used in finishing a piano top. The upper panel of each stateroom door, as well as in the intervening portion of bulkhead, consists of beveled plate glass mirrors, held in place by gold frames, while above each column are gold plated garlands and on the lower door panels are monograms, "Q. C.," entwined around with flowers, which are all in keeping with the lockplates, knobs and other hardware used about the cabin. The upper portion of the side bulkheads, extending the entire length of the cabin, is composed of pivoted sash skylight windows, glazed with chipped glass, which add greatly to the comfort and appearance of the cabin. There are four gangways leading from the cabin to the guards, which are arranged with paneled jambs rounded to about 12 in. radius, and these passage ways are arched by heavy polished brass grills. On each of the rounded panels there are well executed oil paintings, emblematic of the seasons and other appropriate subjects. There are similar panels where the cabin widens to its full width just aft of the cabin circle, and at this point on the starboard side is located the purser's office, while on the port side is the barber's shop, both fitted up in polished brass, hard wood and marble.

The ceiling of the cabin of the Queen City is a decided departure from anything hitherto attempted in steamboat building for the shallow streams in the West. It is made of steel plates that are stamped in a pattern that gives an admixture of the Empire Colonial school of wood

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carving, each plate being about 18 in. square. These are applied to furring strips, each 1 1-4 in. square, that are first secured to the carlines. The metal cover, extending around the entire cabin, gives the appearance of a semi-arch, which is very effective. This metal is treated after the manner that is in vogue in the treatment of metal house finish, with the exception that greater care was used, made necessary by the jolting and twisting movements of the steamer. The same material has been used in the finishing of walls and ceiling of the ladies' retiring room on the port side near the stern, and also forms the wainscoting in the pilot house. The plates used in the cabin ceiling are made in the raised form, with the configurations brought out on the reverse side, the depth of plate proper being 1 1-4 in., with configurations 5-8 in. The latter is relieved by false beams 7 3-4 in. wide and deep that divide the ceiling into six different large panels. This was done in order to increase the effectiveness of the lighting system, the electric bulbs projecting through these false beams at different points. The cabin ceiling is finished in cream white, while the ladies' retiring room is baby blue. The material is the well-known Sagendorph patent.

There are fifty staterooms, having doors which lead out on the guards, as well as those which communicate with the cabin. They are arranged with comfortable beds and upper berths, fitted out with all the completeness of a Pullman sleeper. Each stateroom has a stationary washstand with nickel-plated water urn, secured to the wall and arranged with a self-closing faucet, in place of the usual bowl and pitcher. On the wall are polished brass clothes hooks, mirrors, and other details which go towards making the stateroom complete and convenient for the passengers.

The furnishing of the saloon is in perfect keeping with the rest of the finish, the carpets and upholstering being the best quality velvet and in patterns and colors which harmonize excellently with the general finish.

Before leaving this portion of the steamer it is well to state that the plumbing in the pantry, toilet rooms, and barber shop is of the most scientific design, including the latest patterns of marble wash stands, flush hopper closets, all furnished with nickel-plated pipes, valves, and trimmings.

Above the cabin on the skylight deck we find the texas, or upper cabin, which is about 100 ft. long, with semi-circular shade decks at forward and after ends. The texas contains handsome and commodious quarters for the officers and crew, as well as a separate cabin for a number of passengers. The staterooms in this portion of the steamer have outside windows with glazed and slat shades, but no outside doors. Above the texas rises the pilot house, which is wainscoted inside to the window sills with pressed steel, and sealed overhead with beaded yellow pine. The sides and after portion of the pilot house are closed in glazed sliding sash, while the front has a system of adjustable weather screens. The most important detail in view is the pilot wheel, which is built with a double circle, the outside circle being 8 ft. dia., and the inner circle about 4 ft. dia., each being built up in hardwood segments carefully joined and finished in natural color, with the outer circle finished with ornamental inlaid work. There are 18 turned radial arms, which project beyond the circle, in the form of handles, and connect the circles as well as couple them to the drum or spool, to which the tiller ropes are connected. The center of this wheel is only a few inches above the floor level, as will be noticed in the engraving, so that nearly half of the wheel comes below the floor. The large dia. of wheel is necessary on account of the tiller ropes being coupled directly to the tillers, without having a series of blocks to multiply the leverage. This is also the reason for making the tillers so long. In the pilot house, on suitable stands, are located the various signal bells, speaking trumpets, search light switches and stearing gear, as well as sounding tubes, which lead from large-mouthed trumpets alongside of the bells in the engine room, to enable the pilot to hear whether his signals are sounded correctly. With reference to the engine room bells there are two large bells of different tones, hung on heavy spiral springs, after the manner of the old-fashioned door bells, as well as a large gong, and a sea-going engineer would be quite at loss to know just what was ordered when the pilot "starts in" jingling his bells. But the river man claims that there is less chance for mistakes with this combination of signals than in the case of the single gong. There is an all-round view from the pilot house, as in steering a river steamer it is just as important to see how the stern is handling as it is to see that the bow is swinging around correctly.

The cabins, skylights, texas and pilot house decks are covered with the W. H. Johns asbestos fireproof roofing material, while the entire boiler or passenger deck is covered with 12 oz. Mt. Vernon duck, lengthwise of the boat, underlaid with heavy felt paper, and finished with several coats of mineral paint.

The engine room, deck room, cook house, laundry, pantry, and all of the woodwork on the under side of the boiler deck are protected by coats of fire-resisting paint of dead white finish. All bulkheads and outside work from the top of pilot house to main deck nosing are painted zinc white, which, although very pleasant to the eye, requires constant attention to keep it in proper condition, on account of the soot and cinders from the soft coal burned in the steamer's furnaces. The only "color" used in the exterior decoration is a little red and gold leaf on the various acorns, which form the top finish to the hog chain braces, mast and derricks, and the raised letter signs on the pilot house.

[*To be continued.*]

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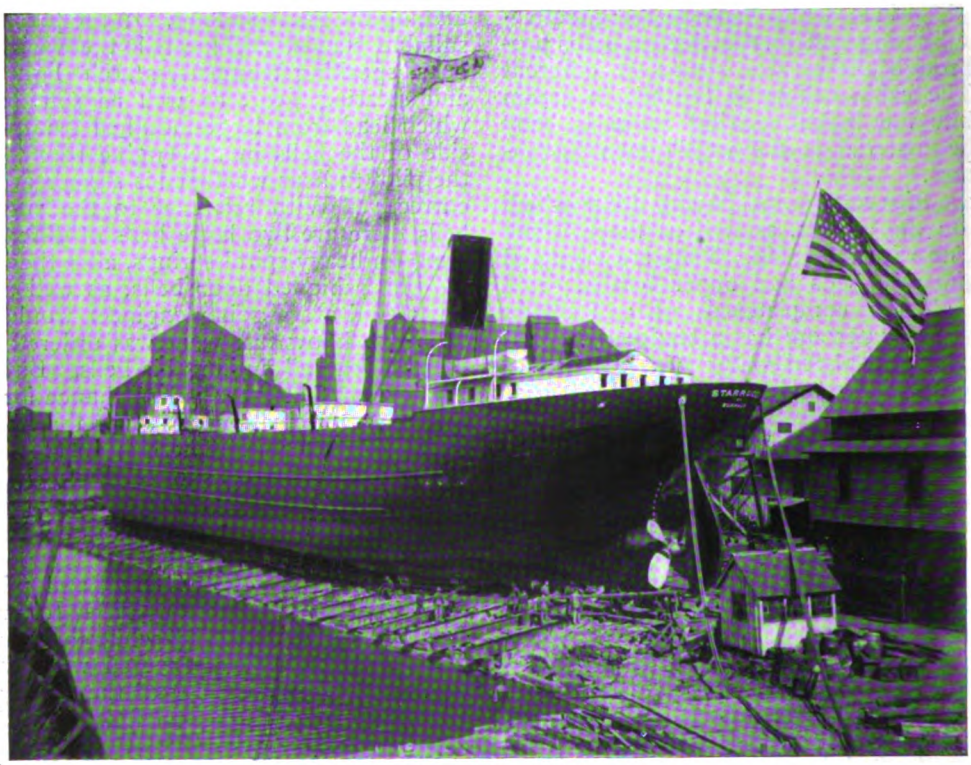
STEEL LAKE STEAMSHIP STARRUCCA, OF FIVE THOUSAND TONS DISPLACEMENT.

The launching of a steamer of 5,000 tons in a body of water only as wide as the beam of the vessel was successfully carried out at the yard of the Erie Railroad Co., Union Dry Dock, in Buffalo, in August. The accompanying views show the S.S. Starrucca before, during, and after launching, and the drawings give an exact knowledge of the preparations for launching and the attendant difficulties. The job was carefully planned by Superintendent Edward Gaskin, and nothing was left to chance. By reference to the drawings it will be noticed that the dock into which the Starrucca was launched is 44 ft. wide at a depth of 6 ft. below mean water level, and is 62 ft. 6 in. wide at the top. The moulded beam of the Starrucca is also 44 ft. Before launching the distance from the center of the ship to the end of the launching ways was 35 ft. 1 1-2 in., and the drop from the launching ways to the surface of the water 3 ft. 6 1-2 in. From the bottom of the keel on the blocks the distance to the water, in a horizontal plane, was 9 ft. 4 1-2 in. The vessel was supported on 25 oak logs of sufficient length to extend from the lower bilge to the distance from the keel, shown in the drawing. These logs were about 20 in. square, and were firmly imbedded in the ground, so that they made a solid foundation. The three end ways forward and aft were securely held in position by shores, that were fitted between cleats on the launching ways and piles driven on the bank. Thus the three end ways were firmly held, so that it was possible by means of levers, three aft and two forward, to hold the vessel, after all the blocking and foundations were removed, until such time as it was considered wise to let her go into the water. The inclination of the ways was 1 5-8 in. to the foot. It was necessary to build the heavy barricade on the outer side of the slip, as will be seen in the photograph of the vessel, taken during the launch. Without this barricade, the launch would not have been possible in so narrow a body of water, as all the water displaced by the vessel was forced against it, and the mean level of the slip was consequently raised. At the time of launching the depth of water on the dock sill was 16 ft. 3 1-2 in. The Starrucca was put into the water complete, without water in the boilers and with no fuel aboard. Her launching draught was 8 ft. 4 1-2 in. aft and 2 ft. 1 1-2 in. forward.



UNION STEAMBOAT LINE S. S. STARRUCCA READY FOR LAUNCHING.

The S.S. Starrucca was built to the order of the Erie Railroad Co., Union Steamboat Line, to carry general cargoes. Her dimensions are: Length over all at rail, 346 ft. 10 in.; moulding length spar deck, 343 ft.; length keel, 325 ft.; depth, 28 ft.; beam, 44 ft.; shear on spar deck, 4 ft. forward, 2 ft. 6 in. aft; shear on gunwale, 5 ft. 3 in. forward, 3 ft. aft. Her decks, main, spar and top-gallant forecastle are entirely of steel, with no wood sheathing. In the main hold there are nine compartments, separated by substantial steel bulkheads, and she is fitted with a

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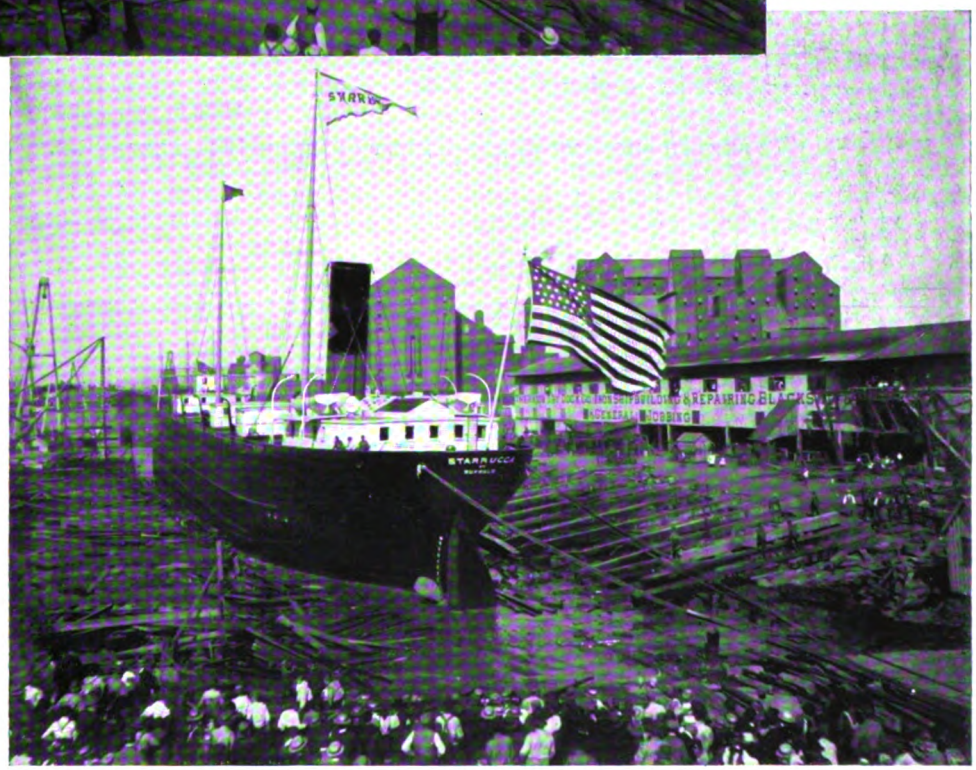
water bottom 54 in. deep. The Starrucca was built with channel floors and zee bar frames strong steamship. A new feature of the boat is her spars, which are made of steel plate in three

INSTANTANEOUS VIEW DURING LAUNCH.



SHOWING S. S. STARRUCCA AFLOAT IN DRY DOCK.

above the tank, and great care was exercised in determining the size and weight of material used in the construction, the result being an unusually courses, riveted with steel rivets. These spars are 100 ft. long, 24 in. dia. at the deck, and are tapered to 6 in. at the truck.

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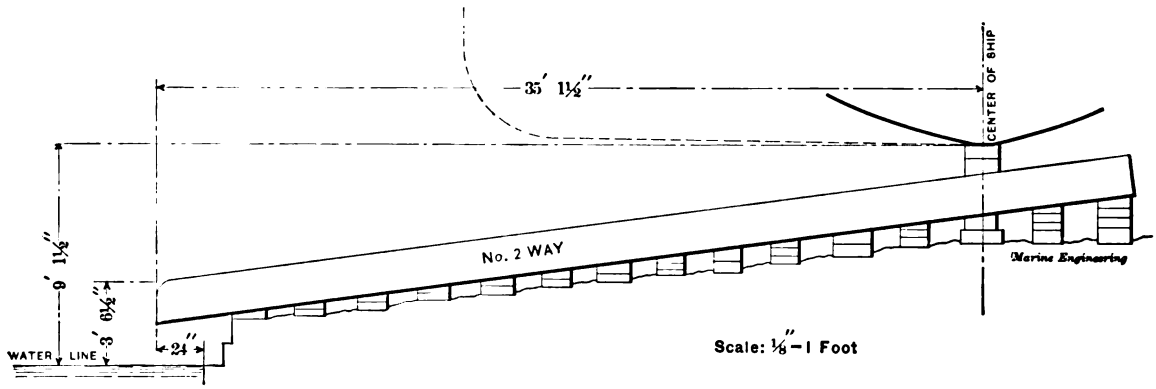
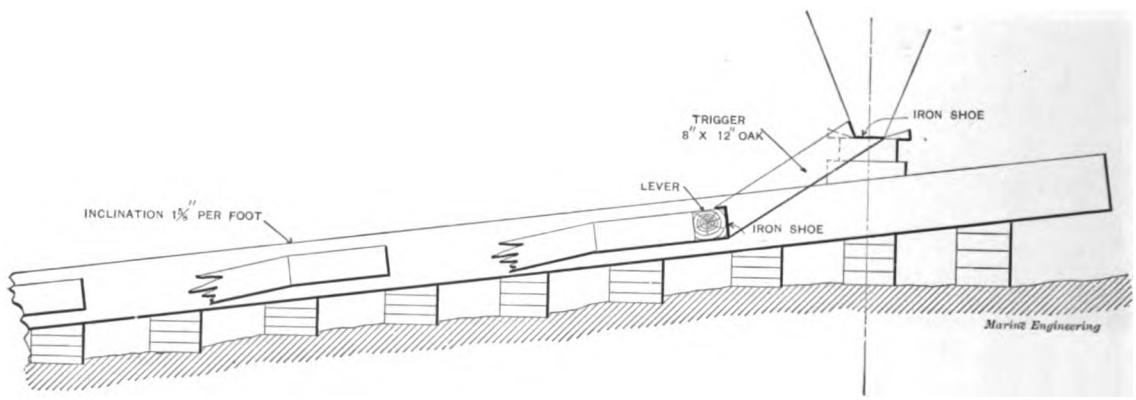
The crew's quarters are located on the spar deck, the deck houses being of wood, with steel coamings of sufficient size to give ample room for all the crew. The quarters are heated throughout by steam and lighted by electricity.

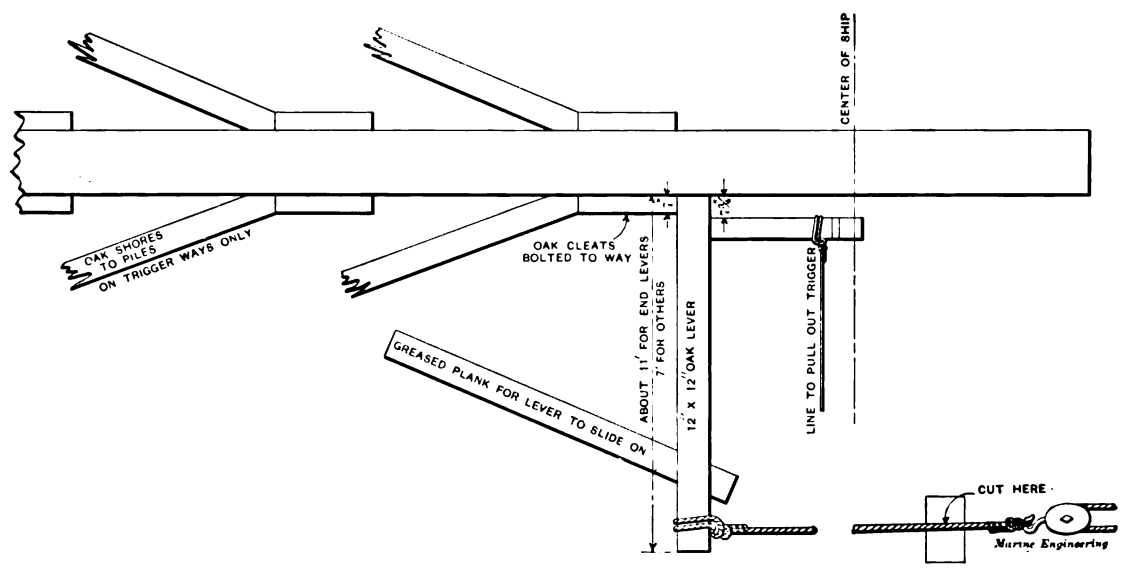
The propelling engines, which were built by the King Iron Works, of Buffalo, are of the vertical inverted triple expansion type, with three cranks and cylinders 22 in., 38 1-3 in. and 64 in. dia., and 42 in. stroke, and are up to date in every particular. The high pressure cylinder is fitted with piston valve, and the inter-



INCLINATION OF WAYS AND DISTANCES FROM WATER LINE.



SKETCH SHOWING ARRANGEMENT OF TRIGGERS—ELEVATION.


CENTER OF SHIP
OAK SHORES TO PILES ON TRIGGER WAYS ONLY
OAK CLEATS BOLTED TO WAY
ABOUT 11′ FOR END LEVERS 7′ FOR OTHERS
12″ X 12″ OAK LEVER
LINE TO PULL OUT TRIGGER
GREASED PLANK FOR LEVER TO SLIDE ON
CUT HERE
Marine Engineering

SKETCH SHOWING ARRANGEMENT OF TRIGGERS—PLAN.

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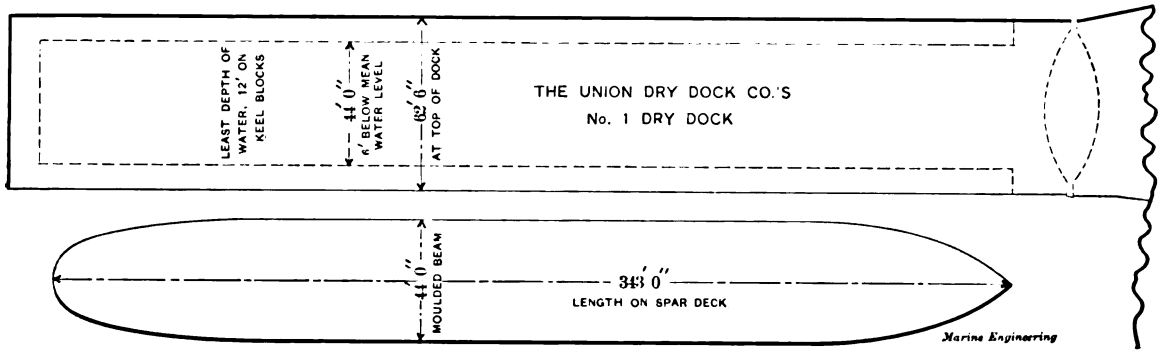
mediate and low pressure cylinders with double ported slide valves, all operated by Stephenson link motion. There are 4 Scotch boilers, built by the Lake Erie Boiler Works. Two are 11 ft. 6 in. dia. and 13 ft. long, and the other two are 11 ft. 6 in. dia. and 12 ft. long. Each boiler has two 44 in. Adamson furnaces, and carries a pressure of 175 lb. per sq. in. The stack is 18 1-2 ft. outside dia., and its top is 60 ft. above the grate bars. The boilers are fitted athwartships, two on each side, with the fire room between. Natural draught is relied upon, a small ventilating fan only being fitted.

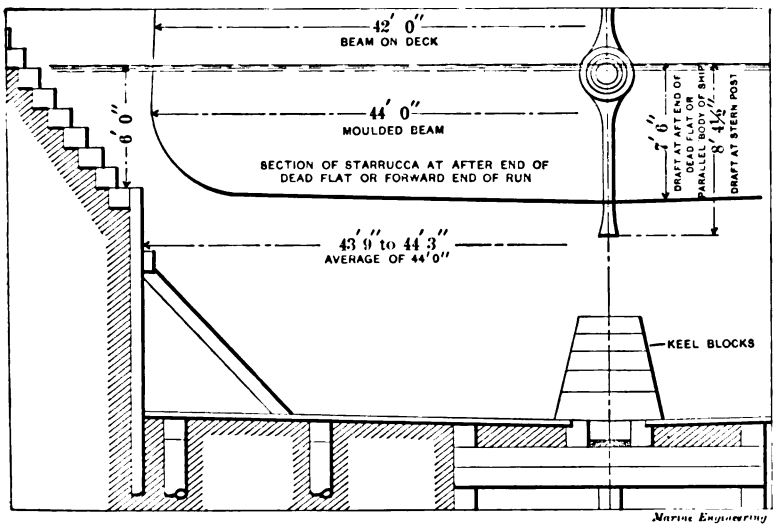
In the engine room there are fitted two vertical duplex ballast pumps, 8 in. and 14 in. by 16 in., of the Deane of Holyoke pattern. To these is attached a single system of piping, with a 10 in. main, and 6 in. suction in each compartment. All valves are operated from the deck. An independent condenser, built by Dean Bros., of Indianapolis, is fitted for the main engines. There are also the usual feed, bilge, and sanitary pumps aboard. The electric light plant consists of two Westinghouse dynamos, each 5 3-4 K. W. 124 volts, direct connected to two Westinghouse junior engines, with 6 in. by 5 in. cylinders. This entire plant was installed by the builders. The steam steering gear is by Williamson Bros. This, with the electric light machinery, is placed in the main engine room, so that it is entirely under the control of the engineer on watch.


LEAST DEPTH OF WATER, 12' ON KEEL BLOCKS
44' 0" 6' BELOW MEAN WATER LEVEL
62' 6" AT TOP OF DOCK
THE UNION DRY DOCK CO.'S
No. 1 DRY DOCK
44' 0" MOULDED BEAM
343' 0" LENGTH ON SPAR DECK
Marine Engineering

SKETCH OF OUTLINE OF DRY DOCK, SHOWING S. S. STARRUCCA ON THE STOCKS.

Between decks there is a double cylinder vertical hoisting engine with a line shaft operating double drums for all the hatches. There are also fitted steam capstans and steam windlass made by the Providence Windlass Co., and two Dunn Stockless anchors, manufactured by the Standard Steel Casting Co., Thurlow, Pa.

Within a week after the Starrucca was launched she was away on a voyage to Chicago with 4,100 tons of coal in her cargo spaces. With this, and her bunkers full, she displaced 5,610 tons on 16 ft. draught. No trial trip was made, but during the voyage a speed of 14 miles an hour was attained. The construction of this steamer, which was carried out under the direction of Edward Gaskin, superintendent of the yard, gave employment continuously to about 500 men. The launch was carried out without the least hitch or delay of any sort.


42' 0" BEAM ON DECK
44' 0" MOULDED BEAM
6' 0"
BECTION OF STARRUCCA AT AFTER END OF DEAD FLAT OR FORWARD END OF RUN
7' 0" DRAFT AT AFT END OF DEAD FLAT OR PARALLEL BODY OF SHIP
8' 4½" DRAFT AT STERN POST
43' 9" to 44' 3" AVERAGE OF 44' 0"
KEEL BLOCKS
Marine Engineering

SECTION OF DOCK, SHOWING VESSEL AT LAUNCHING DRAUGHT.

New Tidal Dock.

The new Prince's Dock, at Glasgow, christened by Royalty recently, is a tidal basin having a water area of more than 34 acres. It is situated on the south side of the Clyde, at a point which will be very convenient for the shipbuilding interests. It is the largest dock on the Clyde, being greater in extent than the Queen's Dock, on the opposite side of the river. The dock consists of an outer basin and three branch basins, with quay frontage of more than two miles. The outer basin is 1,950 ft. long, with an average width of about 225 ft. The dock will communicate by a gate with the new long graving dock. The tidal dock is fully equipped with hydraulic cranes. One of these can lift 150 tons. The dock is a public enterprise.

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THE FORMATION OF CAVITIES IN WATER BY SCREW PROPELLERS AT HIGH SPEEDS.*

BY SYDNEY W. BARNABY, M.I.N.A.

In a paper upon torpedo boat destroyers, read before the Institution of Civil Engineers in 1895 by Mr. Thornycroft and myself, we gave some particulars of the screw trials of the Daring, and described briefly the reasons which led us to conclude that a new phenomenon was manifesting itself. This phenomenon seemingly pointed to the probability that the speed of vessels was approaching a stage at which propulsion by screws would become less efficient, and we said that it appeared inevitable that reduced efficiency must be submitted to as speeds were still further increased.

If a cavity be formed in any manner in the interior of a mass of water it will tend to become filled with water vapor and with any air which might be in solution, since ebullition takes place at ordinary temperatures in a vacuum. We believed that at the speed at which the screws of the Daring began to give trouble such cavities were being formed, and were the source of the great waste of power and of other difficulties which were experienced.

This view met with not a little incredulity at the time, but I believe it to have been perfectly correct. The trials of the Turbinia[1] and the experiments made by the Hon. Charles Parsons afford very strong if not complete confirmation of our contention. Even without this confirmation, the facts that the steps were successful which we took to overcome the difficulty, when we had, as we believed, discovered the cause, afforded strong evidence of the correctness of the diagnosis. As the subject may not have been brought to the attention of many of our foreign friends, I thought a short explanation of the theory of cavitation might be of interest if made as lucidly as its nature will admit and accompanied by a statement of the experience obtained with the Daring, upon which it is based.

Put shortly, the facts were these: With a pair of three-bladed screws 6.16 ft. dia., 9 ft. mean pitch, and 8.92 sq. ft. developed surface, the Daring attained a speed of 24 knots with 3,700 indicated horse power, the screws making 30 per cent slip. With a pair of screws of the same diameter, and practically the same mean pitch, but with a surface of 12.9 sq. ft., an addition of 45 per cent to the surface, the same speed was obtained with 650 less horse power, and with 17 3-4 per cent slip instead of 30 per cent. The number of revolutions required for 24 knots with the screws of small area sufficed to drive the vessel at 28.4 knots, when the blade area was increased. The vibration was unprecedented and dangerous with narrow blades; it was of quite a normal and unimportant character when the blades were widened.

In order to arrive at a clear understanding of what is believed to take place, it is necessary to distinguish between the two cases: Firstly, that of a propeller drawing air from the surface; and secondly, that of the formation of cavities when the propeller is submerged. The effect upon the thrust of a fast running screw when the blades break the surface of the water, or when air penetrates from the surface, is well known. Under such conditions the velocity at which water can flow, due to gravity at a depth below the surface, is equal to $\sqrt{2gh}$, and amounts, for example, to only 8 1-2 knots at a depth of one meter.

If the velocity which has to be imparted to the water in order that it may keep in contact with a portion of the blade situated at a depth is less than $\sqrt{2gh}$, then even if the blade break the surface, there will be no loss of efficiency. This is the case with the slow moving, partially-submerged screws used by Mr. Bancroft to propel barges on the Irish canals, and it also probably explains the good results obtained with the partially-submerged screws of large blade area employed in some shallow-draught tugs on the Continent of Europe. The speed at which water can follow the float of a paddle wheel is limited by the same condition. The particulars of a large paddle steamer, having feathering wheels 20 ft. 6 in. over the floats, which are 9 ft. 9 in. by 3 ft. 6 in. have been supplied to me. I find the slip—i. e., velocity of float in relation to still water—is 11.2 ft. per second. In order that the water should attain this speed it must have a fall of $h = \frac{v^2}{2g} = \frac{11.2^2}{64.4} = 1.95$ ft.; so that, if the top of the float was just awash when at rest, then, considering the action of one float at a time and assuming that at the position of the wheel there was neither a wave crest nor a wave trough due to the motion of the vessel, the water would fall away from the back of the float when in motion for a depth of nearly 2 ft., leaving 1 1-2 ft. only immersed, as it would only be at this depth that the speed of the water due to gravity would equal that of the float. How much the denudation of each float will be affected by the action of those in front of and behind it, is very difficult to say. This might form the subject of very interesting experiments, with models of feathering wheels.

When the screw is sufficiently submerged to exclude air from the surface, the rate at which the water can be accelerated is very much greater. This can be illustrated as follows: water will flow from a tank through an orifice discharging into the open air at a velocity depending upon the depth of the orifice below the surface of the water in the tank. It will flow through the same orifice into the exhausted receiver of an air pump at a much higher velocity

*Read before International Congress of Naval Architects and Marine Engineers, London, 1897.

[1] See June and July issues of Marine Engineering.

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depending upon the degree of exhaustion in the receiver. The velocity in the latter case will be that due to the head of water plus the difference between the pressure of the atmosphere and that in the exhausted receiver. Similarly, the velocity with which water can be made to flow towards a submerged screw is due to the head of water over the screw plus the atmospheric pressure, and there is consequently a definite limit to the speed to which it can attain.

It was not easy to calculate theoretically at what point the breakdown would occur with a given propeller, but a way of attacking the problem suggested by Mr. Thornycroft proved to greatly simplify it, and render its solution easy. His idea was that there must be a definite thrust per square inch of projected screw surface at which cavitation commenced.

A screw propels by putting water in motion sternwards. It effects its object partly by pushing the water with the after face of the blades and partly by pulling it with the forward face. I will ask you to imagine that we have replaced the screw of a ship by a disk of rather less diameter than the screw, and that, instead of revolving the screw shaft, we push the shaft and disk sternwards at such a speed that the disk will momentarily exert the same thrust as the screw. The propelling effect would be the same as that of the screw,[2] and so far as the action between the forward face of the screw blades and the contiguous water is concerned, which is what I wish to illustrate, the action of the disk affords a sufficiently close analogy. As the disk moves sternwards it puts water in motion not only astern of it, but also ahead of it. There being no air between the water and the front face of the disk, a pull can be exerted upon the water, which is forced to follow the disk in the same manner that water is forced to follow the plunger of a pump. But the pull which can thus be exerted by the disk is limited. At a little depth beneath the surface of the water, if the tension exceeds 15 lbs. per square inch (1 atmosphere) the surfaces of the disk and adjacent water are torn asunder, and a cavity is formed between them.

As but a little more than a half of the total acceleration imparted to the water by a screw is estimated to be produced by the suction of the forward surface, it might be supposed that a total thrust approaching to 30 lbs. per square inch (2 atmospheres) might be obtained, but it appears that rupture occurs at parts of the screw surface long before the mean thrust per sq. in. of the whole surface reaches this amount. This is probably accounted for by the fact that the thrust of portions of the screw blade near the circumference is much greater than at portions near the boss.

By plotting the results of a progressive trial carried beyond the speed at which cavitation commenced, we were able to note the point at which the first indications of failure appeared. It is not marked by a sudden change, but by a flexure in the curve of slip, which commences to rise rapidly when the critical speed is reached. The total thrust of the screw at this speed divided by its projected blade area gave a thrust of 11 1-4 lb. per sq. in. (0.75 atmosphere), which is, therefore, about the maximum thrust which can be obtained from a screw working efficiently at a depth below the surface of 11 in., which was the immersion of the tips of the blades in the Daring.[3] For every additional ft. of immersion the total thrust per sq. in. may be increased by 3-8 lb.

By means of the very ingenious expedient of trying a model screw in water heated nearly to boiling point, Mr. Parsons has been able to reproduce and examine the phenomenon of cavitation, and has corroborated our figure of 11 1-4 lbs. as the thrust at which it commences. The difficulty of reproducing analogous conditions with a model lay in the high speed of revolution necessary; but by heating the water, and thus increasing the vapor pressure, lower speeds became possible. Since the tension of the water vapor at boiling point is equal to atmospheric pressure, a screw would cavitate in boiling water at the same speed as it would do if air were admitted to it. In other words, steam would be given off as soon as pressure was reduced. An analogous effect could be obtained by expanding by heat the residue of air in the exhausted receiver before referred to. Then the reduced difference of pressure between the air within and without the receiver would cause the water to flow into the latter from the tank more slowly, and if the temperature of the air were raised sufficiently to cause a pressure inside equal to that of the atmosphere the rate of flow would be that due to the head of water only. The same result would be secured by using a closed tank and exhausting the air in it so that the water would flow from one vacuous region to another, and, I believe, Mr. Parsons has suggested that further experiments might be made in cold water, the surface being relieved from the pressure of the atmosphere.

That cavitation will be the cause of trouble in the future is, I think, certain. Already it is becoming difficult to obtain the requisite area in screws of destroyers without either resorting to an abnormal width of blade or to a larger diameter and pitch ratio than would otherwise have been preferable. The one expedient gives undue surface friction, and the other necessitates a reduction in the rate of revolution, and therefore a heavier engine. The fact that the designer of the Turbinia has been forced—doubtless against his will—to employ nine screws in order to avoid cavitation is an evidence of its influence and a justification of the note of warning we raised in our paper of 1895 after the trials of the Daring.

[2] This would not be true if the movement of the disk were continued far beyond the stern-post, but is nearly so if the movement is confined to the length of the screw.

[3] The figure should vary slightly with the pitch ratio, being less if the latter is high, since the ratio which the suction thrust bears to the whole thrust varies with pitch ratio, but the variation is so small as to be negligible.

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ON NICKEL STEEL AND ALUMINIUM AS MATERIALS FOR SHIP CONSTRUCTION.*—I.

BY J. H. BILES, M.I.C.E.

Improvements in design may be effected by changes in: (1) Arrangements of material; (2) specific strength of material, and (3) specific weight of material. Under the first head are included all changes in structure, which, with a given specific weight of material and a given standard of strength of structure enable a structure to be produced lighter than any previous arrangement. The materials to which attention is called in the present discussion are: (1) Nickel steel; (2) aluminium. Nickel steel has been adopted by the British Admiralty for torpedo boat destroyers. This particular kind has a tensile strength of 37 to 43 tons, with 10 to 15 per cent extension in 8 in. The adoption of some quality of nickel steel for larger vessels, either war or mercantile, or both, is likely to follow. If it were now the same price per ton as mild steel, there seems to be no reason why it should not be at once adopted. But it is not produced at present for much less than three times the price of mild steel. The inducement to adopt it must be an improvement in design. Mr. Beardmore recommends for the shell of torpedo boat destroyers a nickel steel having 52 tons ultimate, 28 tons elastic, and 13 1-2 per cent elongation in 8 in. Mr. Riley, who first made nickel steel in this country, hesitates to adopt as high-tension material as this, on account of the difficulty of making butt connections strong enough.

Two questions are at once opened up: (1) Can advantage be taken of the high tensional strength of this material by reducing scantlings? and (2) If scantlings can be reduced, can good rivet connections be made? It is generally admitted that with uniformly good workmanship and well-designed arrangements throughout, the maximum stresses which come upon a ship are those due to longitudinal bending caused by the passage of waves. When passing over the crest of a wave the deck is in tension, the bottom is in compression. When passing the hollow the reverse is the case. The effect upon the part in tension is dependent upon its sectional area and specific strength. The effect upon the part in compression is dependent on these two things, but also upon the distance between the parts of the material which may be considered to be rigidly fixed, such as the lines of frames or beams. For tensional stresses, any increase of specific strength may be accompanied by a proportional decrease in sectional area. For compressional stresses, the proportional decrease in sectional area can only take place if the distance between the rigid points is reduced also, unless the compression stresses are not severe enough to reach the chosen standard of strength. Generally the maximum tensional strength is greater than the maximum compression stress, the former ranging from 8 to 10 tons, the latter from 4 to 6 tons. This stress is on the ordinary assumptions as to wave heights.

More trouble is found from tensional stresses than from compression, from which it is inferred that the factor of safety for compressive stresses is greater than for tensional. Until an increase of specific strength of material sufficiently great is made to cause reduction in sectional area, and consequently reduction of factor of safety under compression to the point where it equals the factor under tension, it is justifiable to adopt a material of higher specific strength and reduced sectional area. These considerations apply to every detail of the ship, as well as to the ship generally.

In a structure such as a torpedo boat destroyer, or a high-speed light-draught battle steamer, where the compression stresses are much greater than the tensional, and, consequently, the latter are below the standard limit, it is possible that, with the same material and standard of strength, an improvement may be made by reducing the distance between the frames, and accompanying this by a reduction in the sectional area of the parts under compression and tension. The limits of this reduction will be either when the sectional area has been so reduced as to increase the tensional stresses to the chosen standard of strength, or when the reduction in strength of the frames due to the increased number caused by decreased spacings brings on trouble from transverse weakness. If, however, the specific strength of the material be increased, the case is different.

Changes of structure which deserve notice in considering the adoption of nickel are: (1) Reduction of thickness of plating subject to longitudinal tension or compression. (2) Increased local stiffening in this plating. (3) Reduced frame space, and consequent increased number of frames. (4) Reduced weight per frame may be adopted consequent on increased number.

* Read before Institution of Civil Engineers, London, 1897.

In a recent investigation into the cause of a rupture of a steam main on an English steamer, a board of experts expressed some opinions which are of interest. They said: "In view of the high steam pressure now in use, and which will probably still increase in the near future, lap welded wrought-iron pipes or seamless steel pipes are distinctly preferable to either brazed or copper pipes. Brazed copper steam pipes of 3 1-2 in. internal diameter and over should be examined periodically, with the lagging removed, and should be tested by hydraulic pressure, such tests to be made at intervals not exceeding four years. The test pressure should be such as would subject the material of the pipe to a stress of 2 1-2 tons per sq. in. on the sectional area of the material. The risk of explosion of copper steam pipes would be materially reduced by looping them with wrought-iron bands, or by serving them with wire."

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MACHINERY FOR OPERATING LOCKS OF THE ST. MARY'S FALLS SHIP CANAL.

The new lock of the St. Mary's Falls ship canal, opened to commerce August 3, 1896, is the largest in the world, being 800 ft. in length, 100 ft. wide, and about 45 ft. in depth. It is built upon the site of two small locks finished in 1855, which formed the first means of communication between lakes Huron and Superior. Close beside it is the lock of 1881, 515 ft. long and 80 ft. wide, and a short distance to the west the two channels form a Y.

Aside from its size and commercial importance the most interesting feature of the new lock is the mechanism for opening and closing the gates, and for controlling the culverts. Power is derived from the river by means of two 30 horse power turbines located in the basement of the power house, a stone structure which stands between the lower end of the two locks. The turbines are supplied through a large pipe leading from the upper level of the canal, and as the lock has a lift of 18 ft., and the turbines are but little above the lower level, there is always a good head of water. The turbines are geared to overhead shafting, from which three pressure pumps are worked by a rope drive. Each pump has three cylinders. The pumps discharge into three accumulators, which can be weighted as desired, but are usually adjusted to a pressure of 375 lbs. per sq. in. From the accumulators the fluid under pressure is carried out to the lock gates. The gates of the lock are in five sets, known as the upper and lower guard gates, and the upper, intermediate, and lower lock gates. The upper and lower lock gates are at the ends of the lock. The intermediate gates are often used instead of the lower gates when the lock is not crowded to its utmost capacity, and serve to shorten the chamber to 700 ft., reducing the time of filling and emptying. The guard gates are placed in the canal above and below the lock, and are very seldom closed except for repairs. Each set of gates consists of two slightly curved leaves, which swing out from the opposite sides of the lock and meet in the center, forming an arc with the convex side presented to the water pressure and the ends resting against abutments in the masonry. The lower and intermediate lock gates are of course the largest, the leaves being 44 ft. in height, 55 ft. in width, and 3 ft. thick in the center. Each is made of steel, and weighs about 156 tons in air. The gates are opened and closed by submerged wire cables wound upon the drums of six winding machines, three on each side of the lock, opposite the upper, lower, and intermediate gates. A large gear is keyed on the shaft, which carries the winding drum, and this gear engages a pinion which is on the same shaft with a three-cylinder hydraulic engine, driven by the oil piped under pressure. The interior of the drum is provided with a system of gears designed to ease the varying strains to which the machine is subjected as the gate swings around through the water.

For filling the chamber there are six culverts, which start from a well in the forebay, or space between the upper lock gates and the upper guard gates. Passing under the lock gates they run for a long distance beneath the floor, and discharge

LOCKS OF THE ST. MARY'S FALLS SHIP CANAL—VIEW FROM POWER HOUSE.

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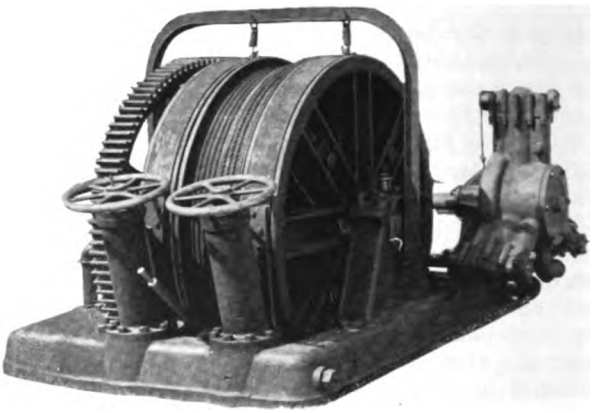
the water through a number of openings, causing it to rise evenly throughout the entire length of the chamber, and avoiding the dangerous currents which would be set in motion if it was all admitted at one end. The six discharging culverts pass out under the intermediate and lower gates, and empty into a well between the lower gates and the lower guard gates. The culverts are all 8 ft. square, and each is opened and closed by a single leaf valve mounted on trunnions and worked by an engine driven by the oil under pressure. These engines, twelve in number, are placed in the culverts, and are of the simplest design. Each consists of a long cylinder containing a piston, which is driven back and forth as the oil is admitted at either end by valves controlled from above. The piston rod is connected directly with the culvert valve, so that one stroke opens the passage and the reverse stroke closes it. Water is sometimes used in place of oil during warm weather, but it cannot be employed in early spring or late fall when frosts are probable.

By closing the upper and lower guard gates the water can be shut off, not only from the lock, but from the culverts as well, and it is then possible to pump the lock dry. For this purpose an entirely distinct set of machinery has been provided. A passage leads from the culverts to the bottom of a well 50 ft. or more in depth under the power house, and from thence to the canal below the lower guard gates. In this well are located three pumps, each of which discharges a 30 in. stream of water. Each is driven by a vertical shaft reaching up into the basement of the power house, and there connected by bevel gears with a 350 horse power Westinghouse steam engine. There is also a drainage pump, which is sunk still lower in the ground, and is driven by the two turbines. It throws a 10 in. stream, and is intended to keep the lock free of any water which may leak in around the gates. The lock has already been emptied several times. Four to six hours are required for the operation, and the amount of water handled in that time is probably 15,000,000 gallons or more.

The statistics furnished by the canal office show a wonderful growth in the commerce of Lake Superior since 1855, when the canal was first opened. In that year the registered tonnage passing through the locks was 106,296. Last year it amounted, including the traffic through the Canadian canal, to 17,249,418 tons. Inasmuch as both canals have been used by Canadian and American vessels the traffic of both is included in one statement. It is stated elsewhere in the traffic report that the proportion of freight carried in Canadian bottoms in the year 1895 was 3 3-4 per cent, or but little over one-thirtieth of the whole.

No record of the number of passages was kept until the season of 1864, when 1,411 registered craft were locked through, against 17,795 registered and 820 unregistered in 1896. A comparison of the number of passages with the registered tonnage shows that the average vessel has increased in size during the last thirty-two years from about 405 tons to 970 tons. The change that has taken place in motive power is quite as remarkable. In 1864 the steamers were a trifle



HYDRAULIC WINDING MACHINE.

less than 26 per cent of the whole, and the sailing vessels a trifle over 74 per cent. In 1896 the steamers were over 75 per cent, and the sailing vessels under 25 per cent. It should be remembered, however, that these figures do not represent the actual number of craft on the lakes, but only the number of passages through the canal.

MECHANICAL EFFICIENCIES OF MARINE ENGINES WITH NUMERICAL ILLUSTRATIONS.

BY BERNHARD A. SINN, M.E.

When determining the power necessary to propel a vessel, it is often desirable to know the mechanical efficiency of the main engines of the vessel in question, and lack of knowledge on this subject is often the cause of large errors in the final result.

The mechanical efficiency of a marine engine is the proportion of power given to the propeller to that indicated by the main engines; or in other words, it is the I.H.P. of the engine, less the friction of all moving parts, stuffing boxes, and bearings. This friction varies with revolutions and power, and is sometimes roughly taken as varying half directly as the revolutions and half directly as the power. As we do not know the exact percentage of friction that is taken up in the various types of engine, we can state at the point neither the quantity nor variation of the frictional forces. The stationary engine has sometimes been taken as a model, as far as frictional wastes are concerned, but the conditions governing the two types are so different that any such comparison is valueless. In the stationary engine we do not have the large lines of shafting, or the constant derangement of the engines due to the twisting and yawing of the vessels. It is thus readily seen that this difference in the two types will cause the mechanical efficiency of the marine engine to fall considerably below that of the stationary type.

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Experiments so far made with marine engines to determine their mechanical efficiency, are very few in number, hardly sufficient to form the basis of a calculation. The three most extensive that have come to my notice are those of Isherwood on tug No. 4, Froude on the Greyhound, and Morin on the Pelican. In all three of these cases the developed power was obtained from a transmission dynamometer attached to the propeller shaft, and the friction of the bearings and stuffing boxes was not included in the dynamometric power, although an attempt was made to correct for these additional wastes. These experiments, however, were made before the dynamometer and indicator were as accurate and reliable instruments as they are to-day, and the error that crept into the result is most likely quite considerable.

There are several ways of determining mechanical efficiency, and the means for obtaining it is as follows:

The simplest way, of course, would be to find the developed horse power by means of a dynamometer, but the only practical point of application is inside of the vessel where the friction of the stuffing box and stern bearing cannot be obtained. If we could apply the dynamometer at the end of the tail shaft, between the propeller and the stern bearing, the solution of the problem would be at hand.

We can arrive at the friction of the whole plant when the vessel is in dry dock, by placing a prony brake on the tail shaft in place of the propeller, and finding the difference between the indicated and the developed horse power. But we have not the same conditions here that we have in the actual case, because the vessel in dry dock does not "give" as it would in an ordinary sea.

A third way of finding the mechanical efficiency of a marine engine is to derive the thrust or work, by a method of analysis. If we take a propeller formula, like that of Froude, if necessary modified to permit of a variation in shape and area, other than the ones used in Froude's experiments, we find that, no matter what the form of the expression is, there is always a term which represents work, and the work is I.H.P. multiplied by engine efficiency and propeller efficiency. When we have, therefore, the results of a trial trip complete we can always find the amount of power put into useful work, in other words we can find which portion of the indicated power is wasted and which utilized. Consequently the amount of waste can be found in the marine engine by means of a suitable formula, and of progressive trial data.

At the lowest speed, it can safely be assumed, that all the power that is not given to the screw is used in overcoming the friction of the engine in itself, and not due to the load. Consequently, at the revolutions given for the lowest speed, we know the corresponding friction, neglecting the effect which must of necessity be small when less than 5 per cent of the maximum power is used.

At the next highest speed we find that a different percentage of the power is used in friction. As we can find the amount at this speed and consequently at the revolutions the engines are making in order to attain this speed, we can find the amount of friction caused by the moving parts of the engine, irrespective of load, by simply proportioning the friction found in the first case to the respective revolutions in both cases. Then the residue is load friction. We can now go directly to the highest speed, and by simply proportioning our load friction to power, and primary engine friction to revolutions, find the total friction at the highest speed.

To illustrate numerically. In one engine the maximum power was 1,800 I.H.P., and at the lowest speed given, it was found that but 57 I.H.P. was necessary. Of this 52.2 I.H.P. was used in overcoming the friction of the engines. Now as the power was only about 4 per cent of the maximum, it may be safely assumed that the engine friction took all of this, and the effect of load was nil. At the next lowest power 102 I.H.P. was used in friction. Now, as engine friction is allowed to vary directly as the revolutions, we see that 73 I.H.P. was taken up by this friction, leaving 29 I.H.P. for the effect of load, which at this point was about 15 per cent of the maximum. Now proportioning the load friction to power and going to the highest speed, 128 I.H.P. was used in friction of the load at the maximum power. Similarly we may proportion the friction of the engine itself to revolutions and find at the maximum speed and power 142 I.H.P. utilized in this kind of friction—therefore, we have 270 I.H.P. used in friction. The total power being 1,800, we see that the friction is 15 per cent of the maximum, in other words our mechanical efficiency in this case is about 85 per cent.

The results of an extensive investigation in the course of which this method was used, leads one to form the following general conclusions: For a modern triple or quadruple expansion engine, vertical and built since 1888, about 88 per cent would be the mechanical efficiency. For a modern vertical, triple-expansion engine, built after 1884, about 86 per cent. For a modern horizontal, triple-expansion engine, built after 1885, about 85 per cent. For a modern vertical compound engine built since 1885, about 83 per cent. For a horizontal compound engine built since 1885, about 82 per cent. For a compound engine built since 1875, about 80 per cent. For a beam engine about 70 per cent. For a torpedo boat engine or light vacht engine as high as 90 per cent would be allowable. These values, although derived from particular cases, will in general give consistent results. A great deal, however, depends on the builders, and the care with which the machines are placed on board the ship. Frequently good work in the shops is offset by carelessness in the vessel, as much as 5 per cent. waste from this cause being observed in one vessel.

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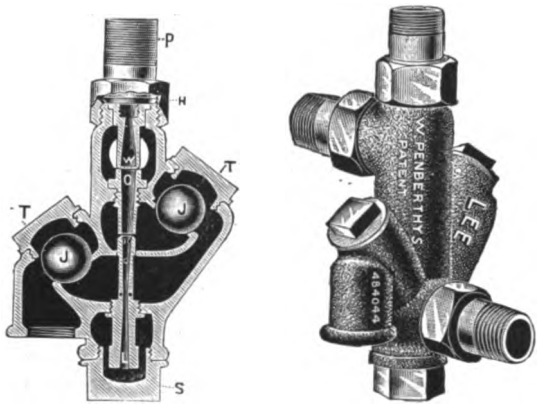
IMPROVED APPARATUS.

Lee Ball Valve Automatic Injector.

This injector is of the single tube automatic type. Steam entering through the jet W mingles

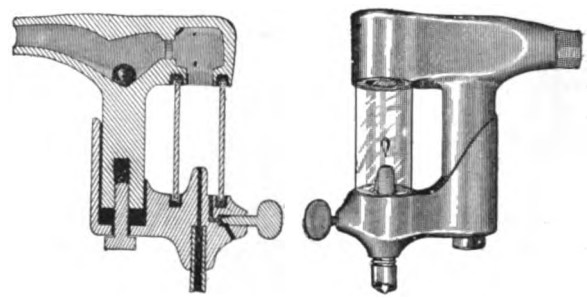


LEE BALL VALVE INJECTOR.

with the water in combining tube O, and the combined steam and water escaping at the space between the combining and delivery tubes lifts the two ball valves J J and is discharged at the overflow. When sufficient velocity has been acquired to send the jet through the delivery tube the upper ball valve seats, the escape through the spills in the delivery tube finding an exit to the overflow by lifting the lower. When sufficient velocity is acquired to send the entire jet through the delivery tube and into the boiler the overflow ceases and the injector is at work. Rubber ball valves are substituted for the usual lifting or swinging overflow metal valves, which are often a source of trouble caused by accumulations of scale. These balls are of vulcanized rubber impervious to liming or corrosion and easily removable by unscrewing the caps T. T. The injector is the invention of W. Penberthy, and is made by the Lee-Penberthy Mfg. Co., 101 Abbott street, Detroit, Mich.

Automatic Positive Feed Lubricator.

A new form of positive feed lubricator is here shown. It is entirely automatic and is operated thus: The adjustable arm is attached to some of the moving parts of the engine, and the pawl attached imparts motion to the back ratchet wheel. An eccentric on the inner hub of the



LUBRICATOR SIGHT FEED ATTACHMENT.

back wheel operates a bell crank having a pawl on the upper end, which moves the top wheel one tooth for each revolution of the back wheel. The face of the piston is provided with a leather cup packing, and an oil outlet running up one side of the piston frame to a pipe connecting with the point to be lubricated. The oil reservoir is drawn on to a stationary piston by means of the feed screw of the top wheel. The oil is thus forced through the outlet and connecting pipe positively and at regular intervals. There is ample provision for adjusting the feed at any desired amount of flow. The back ratchet wheel has three rows of teeth, each row containing a different number of teeth. The adjusting arm and pawl can be set to slip one or more teeth at a time. For high speeds a lubricator can be furnished with means of adjustment, which the manufacturers say will meet every requirement. The action of the lubricator is stopped automatically when empty, and a check valve in the outlet prevents the escape of oil if the removable reservoir is taken out. Many

SINGLE AND DUPLEX PATTERNS, AUTOMATIC POSITIVE FEED LUBRICATORS.

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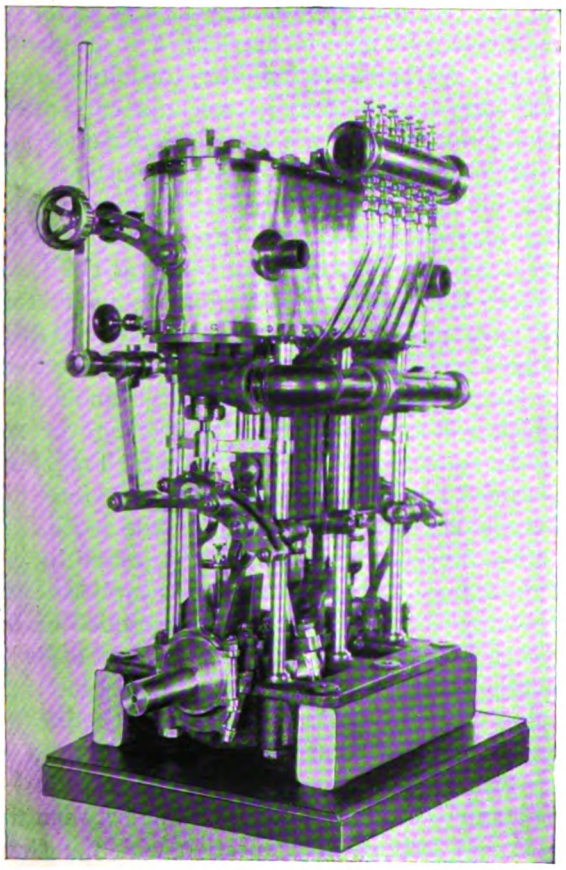
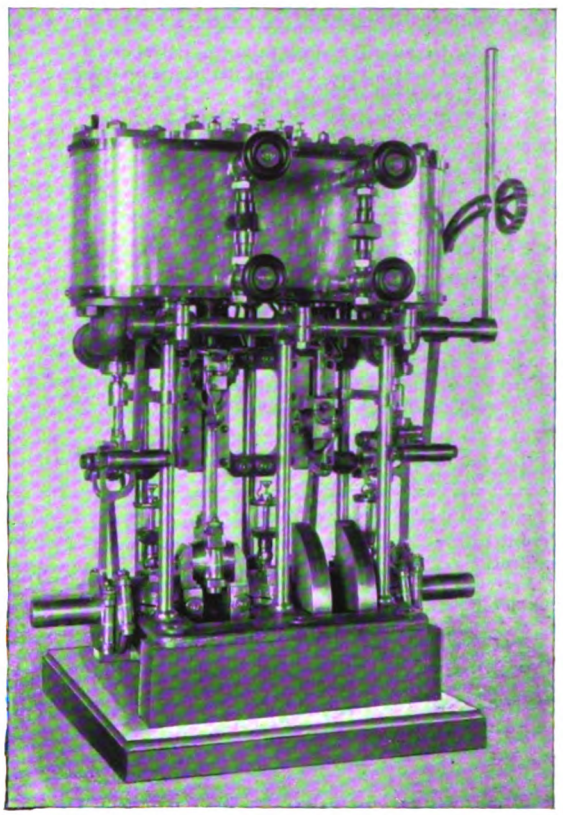
lubricators of this pattern have been fitted on engines and the manufacturers report that they work satisfactorily, feeding oil or grease of any consistency to any distance, and being unaffected by changes in temperature. A great convenience with this form of lubricator is that it can be placed in the engine room and connected with the thrust block, or an outboard bearing, with the certainty that lubrication will be regular. For non-condensing engines or where oil in the cylinders is necessary a sight feed attachment is provided, to be used in connection with the National lubricator or as an independent sight feed, as desired. It is, however, not essential to the effective working of the lubricator. The device, as illustrated, is very simple, the glass being of large diameter with an automatic valve which shuts off steam instantly should the glass break. The glass and packing are adjusted with a single adjusting bolt and the glass can be readily removed and cleaned by simply turning a thumb screw. The lubricator is also made in Duplex form, as shown in the illustration on the opposite page. It can be had in a variety of sizes suitable for the work to be done. The manufacturer, the National Lubricator Co., 107 Montgomery St., Albany, New York, will be pleased to answer any inquiries regarding the apparatus.



STANDARD PATTERN, FORBES ENGINE.

Standard Pattern High-Speed Engine.

Every one who has had anything to do with small power yacht engines is aware that their cost is considerable, as they are generally designed to meet particular requirements. This fact has induced W. D. Forbes & Co., of Hoboken, N. J., to put on the market a line of small power yacht engines of sizes which will enable them to be made in numbers, thus materially reducing the cost per engine. The first size of these engines is here illustrated; the cylinder dimensions are 2 3-4 in. and 5 3-4 in. by 4 1-2 in. The cranks are usually set at 180 deg. apart, although the illustration does not show the cranks in this position. All the forgings are made without welds; each crosshead and piston rod is a solid forging and the connecting rods are hollow. The interior of the cylinders are accurately machined on the lower head in order to get as little clearance as possible. The engine runs up to 600 revolutions per minute and will keep on running at this rate of speed provided the lubrication is properly looked after. All parts can be lubricated while the engine is in motion. The link, it will be noticed, is of the double bar type, and the entire design has been given a great deal of thought and care. The engine is highly finished and the material is the best obtainable, and the workmanship very thorough. The weight of the engine, as shown, is 300 pounds.



STANDARD PATTERN, FORBES ENGINE.

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Engineers and other officers of steam vessels are cordially invited to call at our office, where will be found the leading marine publications of this country and Great Britain.

Letters and other mail matter can be sent to our care and will be forwarded or held until called for, as desired.

While many of the shipyards of this country are slack of work, or as nearly idle as yards can be and yet keep going, foreign builders, especially British, are busy on vessels for the American trade. Indeed, to keep a complete record of all vessels recently built, or building, or planned, for the purpose of capturing American dollars, would be a difficult task for a statistician. Not to go further back than a year the number of new vessels for this trade, for which orders have been given abroad, is astounding. Taking first the port of New York, not only have single vessels been added to existing lines, but entire fleets of steamers are being prepared for a share of the ever-increasing transatlantic trade. The newest addition to the North German Lloyd service between New York and Bremen, will attract more widespread public attention, of course, than a whole fleet of minor vessels. But such ships are money spenders rather than money makers, when compared with the intermediate type of vessel, which does not attract attention outside of shipping circles, but which nevertheless earns steady dividends for the shareholders. A thousand men could tell the name of the Kaiser Wilhelm der Grosse to one who could correctly name the four great freight and passenger steamers which the North German Lloyd recently added to its fleet, and the company has yet more to come, including the new greyhound, the Kaiser Friedrich. The Hamburg-American line has also largely increased its carrying capacity with the monster Pennsylvania, and it has a few more dollar winners on the stocks, ranging from a sister ship to the Pennsylvania down to a modest 9,000 tonner. Then another Continental line, the Holland-American, appears to be doing pretty well in a business which American capital fears to venture in. In former days it was content to travel along quietly, with second-hand liners, outside of the record class. Now, however, it has moved up a step into the intermediate class with the 8,000 ton Rotterdam, built, and the 10,000 ton Staatendam, building. The White Star has seen the German lines, and gone one better with the 17,000 ton Oceanic, which, according to report, will be able to overhaul a torpedo boat at sea. An immense freighter, too, the Cymric, will soon be added to its splendid cargo fleet. The Cunard line is not talking, but rumor says it has been keeping an eye on the Turbinia. As this line has always had coal to burn, something big may be looked for. French capital, too, seeks an increased share of trade, as the Compagnie Generale Transatlantique is understood to have placed orders for two 22-knot fliers. Next comes the new New York-London service of the Wilsons, Furness-Leyland combination, which will soon announce the sailings of five 8,000 ton vessels. The Atlantic Transport-National line combination has also four big vessels booked for the same route. Another entire fleet has been put in operation by the Prince line, to run between this and Mediterranean ports. With the experience this line has had in Central and South American trade, it ought to be able to correctly judge the trade value of a line here. Then the Allan line has purchased three steamers for the New York service. There is also a movement among West of England interests to establish a line between this port and Milford in connection with the Great Western Railway of England. Now, as to ports other than New York. William Thompson & Co., of St. John's, New Brunswick, have placed orders for four 4,000 ton steamers to trade regularly from that port to Liverpool. Donaldson Brothers, of Glasgow, are adding a 6,200 ton steamer to their Canadian fleet, specially fitted to carry live stock and dairy produce. Elder Demp-

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ster & Co. have two 11,500 ton steamers building for their Canadian-Liverpool trade, and also an 8,000 ton cattle and cargo vessel, arranged so that it can be at any time converted into a passenger vessel. They have put larger boats on their line to Bristol, and have a regular line running direct to Manchester. The Warren line, which calls at Canadian ports and Boston, has added an 8,800 ton steamer to its fleet. The Dominion line is also figuring on a new ship. Then the project to establish a fast mail line between Canada and Britain, of which Petersen and Tate are the sponsors, is to be reckoned on. This calls for a fleet of 10,000 ton vessels of top speed, and a subsidy of $800,000 awaits the promoters. A new line is to be established between Philadelphia and English ports, to be operated in connection with the Philadelphia and Reading Railway. This will require the services of several steamers which are under charter. At Newport News the Transatlantic freight carriers are to be added to by two 11,000 ton vessels, orders for which have been placed by Furness, Withy & Co., managers of the Chesapeake line. Going further south, the West India and Pacific Steam Navigation Co., which makes New Orleans a regular port of call, has given orders for two 5,000 ton vessels. Among other projected Gulf lines is one between Bordeaux and New Orleans, and the Hanseatic line is considering the advisability of commencing regular sailings between Galveston and North Sea ports. Pierce, Becker & Ilardi, of Messina, have ordered a 4,500 ton steamer for their fruit line to American ports. On South American routes, several new vessels will soon be carrying cargoes. The German lines are spreading out in this trade, and Lamport & Holt have decided to add a 5,600 ton steamer to their South American fleet. And the contribution of American genius to these grand fleets of ocean vessels consists of a few auxiliaries hidden in engine room recesses.

One of the best things that could have happened to awaken the public mind to a proper appreciation of naval needs was the recent trip of the U. S. S. Indiana to Halifax to be docked. It was calculated to touch the pride of Americans and awaken feelings that no amount of cold explanation could have stirred. That a first-class naval power should have been compelled to borrow the use of a dock in times of peace to execute, not an emergency job, but the very ordinary operation of cleaning and painting the hull, was theatrically ridiculous. More, it was humiliating to every self-respecting American; this spectacle of the millionaire borrowing a utensil from his poor neighbor to cook his victuals in. The fact that the British authorities were extremely courteous only made the position the country was placed in more unbearable. However, it is to be hoped that this incident will be indeed the starting point for very energetic measures to provide the Navy with proper docks. In one way it is fortunate that dock building on an extensive scale was not commenced before this, as in very recent times the size of vessels has increased so enormously that docks of a few years ago are inadequate for all needs now. When the subject of docks is discussed, it is the fashion to speak of the British nation as an ideal. But taking recent advances in naval architecture as a measure of what is to come, the British will also have to do a little excavating. There are only four docks in the British Isles which are big enough to take in the 700 ft. White Star liner Oceanic, now building. Not one of these is owned or controlled by the British Government. The location and dimensions of these docks are of interest: Prince of Wales Dock at Southampton, 750 ft. long, 87 1-2 ft. wide, and 28 1-2 ft. over sill; Mersey Docks and Harbor Board at Birkenhead, 752 ft. long, 85 ft. wide, and 26 3-4 ft. over sill; Clyde Navigation Trust at Govan, 900 ft. long, 85 ft. wide, and 26 ft. over sill, and the Alexandra Dry Dock at Belfast, in three sections, which, over all, measure 825 ft. in length, 80 ft. breadth, and 25 3-4 ft. over sill. Strategically, the disposition of these docks is excellent, but it will be noticed that the depth of water in most is not excessive.

We note with pleasure the following paragraph in a recent issue of Seaboard, which touches on a happening commented on in our last issue:

In the investigation of the charges brought against Captain Atkinson, of the steam yacht Hermione, which collided with the passenger steamer Saratoga on the Hudson on August 12, the fact was developed that he lowered a boat and offered assistance to the steamboat, but that the Saratoga continued on her way without inquiring the extent of damage done to the yacht. The report was circulated at the time that the Hermione had proceeded on her course without ascertaining the condition of the steamboat, but when the case was brought before the inspectors it was learned that Captain Atkinson had fulfilled his duty, and the charges against him were dismissed. Captain Atkinson has always been known as a careful and trustworthy navigator, and the facts as brought out by the inspectors' investigation prove that he did all he could after the collision.

The finding of the inspectors is entirely creditable to Captain Atkinson and his crew.

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Discussion on Breakages of Crank and Propeller Shafts in the Mercantile Marine.

During the recent International Congress of Naval Architects and Marine Engineers in London, one of the most interesting discussions of a practical character followed the reading of the paper on crank and propeller shafts by G. W. Manuel, engineer superintendent of the Peninsular and Oriental Steam Navigation Company. This paper, with the accompanying diagrams, was published in our last issue. The P. and O. Company is, probably, the owner of the largest steam tonnage, held under one ownership, sailing under the British flag. The total tonnage is about 280,000 tons. Under a new contract made with the British Government, the company will receive $1,650,000 annually for carrying the mails to India, China and Australia. In engineering circles the company has been noted for a tenacious adherence to the single-screw type of steamship.

Sir John Durston, Engineer-in-Chief to the British Navy, opened the discussion by referring to Mr. Manuel's statement about twin screw vessels. It was true that twin screws had not lessened the liability to accident, but had made it possible for a vessel to reach port after a mishap to one engine. This advantage justified the adoption of twin screws. As to hollow shafts, the speaker had found them very satisfactory, and in the opinion of the Navy, a better working material was secured by the use of these shafts. The center of an ingot was likely to be the most defective part.

Passed Assistant Engineer Walter M. McFarland, United States Navy, said hollow shafts had given very satisfactory results in U. S. war vessels.

J. T. Milton, of Lloyd's, said that while shafts were made in conformity with rules which prescribed certain factors of safety, yet no rule could provide for the safe working of shafts if they were not properly treated, if out of line or heated at the bearings while at work. To avoid mishaps close observation and prompt remedies for defects were the safeguards. It had been maintained that the three crank engine had given better results than the older types. He favored the built up design of shafts. In these the masses of metal which constituted the component parts are comparatively small and are more likely to be sound forgings than the larger masses which formed the solid shaft, which was machined to shape. Regarding the forging of shafts, he referred to the paper read, in which the author had described the manufacture of shafts from small pieces of scrap iron, cuttings of boiler plate, good ship iron, forge scrap, old bolts, horse shoes and angle iron welded together, forged into billets, reheated, rolled into bars, cut into lengths and forged into convenient sized slabs for welding up into a shaft. In the later days of iron shafts the more powerful hammers and suitable furnaces and fuel made the forgings more reliable. But even with every precaution, every iron shaft contained some flaws or defects, and when these flaws existed in the neighborhood of the greatest strains in work they often extended until the safe limit was passed. The author had also referred in his paper to the forging of steel shafts from scrap, chiefly from ships' plates. The speaker was favorable to this material, as one property of steel scrap was its homogeneity, in which respect it was superior to iron. For a steel shaft he would prefer a tensile strength of 30 tons rather than 33 tons. A high carbon steel in a shaft was unreliable, as, if the shaft once began to go it would break with a snap. As to the reasons for flaws in shafting, such as had been illustrated by the author, one was likely the corrosion that took place between the brass and iron, and another the separation of the molecules in the metal due to longitudinal and not torsional stress. In places where a gun metal liner was shrunk on a rigid point was obtained and a great strain resulted at the end of the liner. Liners might be longer and tapered down so that they would be thick enough only to keep tight. Then, if corrosion took place between the shaft and liner, it would be possible to cut a piece off the liner. Failures of shafts often occurred in tramp steamers which were sent to sea so light that a large part of the propeller was exposed. The blades consequently struck the water a violent blow and the concussion was very hard on the shafting.

John I. Thornycroft said the blows from the propeller blades subjected the shafting to varying stress depending on the number of blows. He favored the tapering of the gun metal liner on a shaft.

A. Holt held that stresses should be calculated in terms of the propeller, and not in terms of the engine. During last winter season twenty-three vessels in the North Atlantic had broken tail shafts. They were tramp steamships for the most part. He favored the use of a propeller of as small diameter as possible.

A. E. Seaton was of opinion that the better framing of engines nowadays, rather than the use of steel, was the cause of fewer shaft failures. The use of white metal was also a contributory cause. Hollow shafts had advantages, as by boring out, the bad metal in the interior was got rid of. Inspection of shafts which did not ignore even microscopic cracks was largely responsible for good results in modern practice. He favored the use of scrap steel in shaft making. In place of liners he would propose the use of white metal bands. In sandy water lignum vitae wore away quickly while white metal bearings would last for years.

Mr. Mudd said most of the shaft failures occurred with tail shafts. Corrosion caused by galvanic action was the chief cause of these failures. A rubber envelope even 1-8 in. thick would preserve a shaft by preventing sea water getting at the metals and causing corrosion at the junction between the liner and the steel shaft. Galvanic action cut a fine nick in the shaft and the stresses acting on this point, it was only a question of time when the shaft would break. He cited cases in which a nick 5-8 in. deep, and extending to a distance of 1 in. from the end of the gun metal, had been observed.

G. W. Manuel, in replying, at the close of the discussion, said that while hollow shafts had been extensively used in naval work they had not been so generally used in mercantile vessels, where more exhaustive tests were possible, and he had concluded that hollow shafts were not as good as solid shafts. In a case in point in which a shaft had been deeply corroded, had the center been removed there would not have been sufficient thickness of metal left to withstand the strains. Speaking of longitudinal strains he could not understand how they would be created if the bearings were properly adjusted. His experience had not paralleled that of Mr. Seaton with respect to the use of Lignum vitae in sandy waters. In ports in China and India there was lots of sharp sand in the water, and the wood strips lasted about seven years.

In England, under the provisions of the Merchants' Shipping Act, stowaways are regarded as part of the crew of a vessel.

During the twelve months ending July 1, 1897, there entered the port of Liverpool, 11,473,421 tons of shipping, an increase of 426,962 tons over the preceding twelve months.

The little torpedo boat Turbinia made a new speed record at the Spithead naval review. She was sent down the lines of warships at top speed, reaching a velocity of 35 knots at times, and this, it is reported, on a steam consumption of 14 lbs. per I. H. P.

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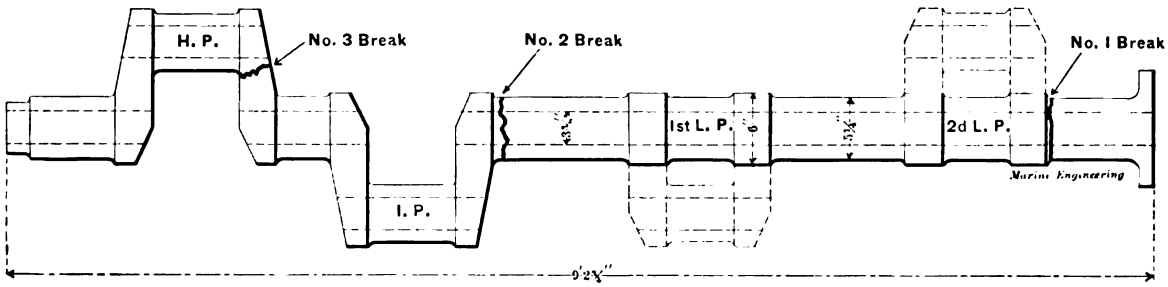
MISHAPS AT SEA.

Failure of Torpedo-Boat Crank Shaft.

During the recent trial of the U. S. torpedo boat Rodgers a bad smash up occurred in the engine room following a break in the after crank of the port engine. At the time the boat was running her speed trial near Annapolis. Everything was going in good order, and those aboard were highly pleased with her behavior, when just as the last stake boat was almost reached, a cloud of steam was observed to rise from the port engine hatch. There is a skylight 7 ft. 9 in. by 2 ft. over each hatch, and fortunately that over the port engine was raised. Steam was instantly shut off by using the levers on the deck. The engine room staff made quick time up the ladders, and Chief Engineer John R. Edwards, U. S. N., who was last to leave the engine room, was not only severely scalded, but badly bruised by the combined efforts of the crew, who had "walked all over him" in their haste to get out. The Rodgers is a twin-screw boat 160 ft. long and 16 ft. beam on the L. W. L., and with the engines indicating 2,000 horse power averages 24 1-2 knots. An examination of the engine showed that it was a complete wreck. The crank shaft was fractured in three places, as shown in the sketch, the H. P. and L. P. cylinders were in scrap, piston and connecting rods were bent, and the bearing bolts of the crank shaft were torn out. The steam main had also been fractured, and had steam not been shut off so promptly from above, deaths might have been reported. The engines have cylinders 12 in., 19 1-4 in. and two 22 in. with 16 in. stroke. When the breakdown occurred the engines were running about 400 revolutions per minute. After a hasty examination the boat was headed for Annapolis with the starboard engine working and Chief Engineer Edwards was sent ashore to hospital.



FRACTURED STEEL CRANK SHAFT OF U. S. TWIN-SCREW TORPEDO-BOAT RODGERS.

We are informed that the steel forgings used in the engines were made under lower specifications than those now in force, viz.: 58,000 lbs. tensile strength and 28 per cent. elongation in 2 in. Under the existing specifications such forgings have a tensile strength of 80,000 lbs., an elastic limit of 45,000 lbs. and an elongation of 26 per cent. The crank shaft was 9 ft. 2 3-4 in. over all, 5 1-4 in. dia. in the bearings, and bored with a 3 3-8 in. hole. The first break occurred just aft of the after web of the second L. P. crank. Another break occurred in the same position relatively at the I. P. crank, and the last in the H. P. crank web close to the pin. From the engines aft to the propellers the shafting is solid. Until the vessel is docked and examination is made it will not be known exactly whether the original break was due to inherent weakness in the shaft, interior cracks, for instance, or to something in the water having jammed the port propeller.

A new shaft has been ordered, this time from the Bethlehem Iron Co.

CORRESPONDENCE.

[Communications on matters of interest to marine engineers, for insertion in the correspondence department, are solicited. These, wherever possible, should be supplemented by rough sketches or drawings, which will be reproduced if necessary to illustrate the subject, without cost to the writer.

Full names and addresses should be given, but publication of these will be withheld where requested.

We do not assume responsibility for the opinions expressed by correspondents.]

Wants Data About B. T. U.

I should like to know if there are any full data obtainable of the number of B. T. U. per square foot of heating surface in a feed heater, or cooling surface in a condenser, as the case may be, which goes into effective work in heating water or cooling the steam. I should like to have figures giving B. T. U. per square foot for various diameters, thicknesses and materials of tubes. B. T. U.

Regarding Rules for the Propulsion of Ships.

In the last issue a correspondent asks two very vague questions regarding screw propulsion. He wishes to know "a rule for figuring the power necessary to propel a vessel at any given speed," and also "what is the power required to revolve a screw propeller at any given speed?" That no rule can be given for determining the power necessary to drive a ship at any given speed is one of the first propositions made plain to a student of naval architecture. That no rules can be derived at the present time will be seen from the following: The power necessary to propel a vessel is the power necessary to overcome the resistance of the vessel. It is the I. H. P. less the engine friction and the propeller losses. Consequently the whole subject revolves about the resistance of the ship, as this varies with the nature of the vessel's bottom, the shape and the speed. It is a well known fact that up to the present time no formula has been derived which will properly take care of all the different factors involved in the case. The only means we have at hand, except by making model experiments, is to analyze the performance of a ship similar to the one in question, and by the use of experience and the laws of comparison determine the power necessary; but of course it must be kept in mind that this is not an absolute method, merely comparative, and without the original data we are all at sea. As to the second question, there is absolutely no way of determining the power necessary to revolve a propeller at any given speed. In fact the question is so vague that I hardly catch its meaning. What I suppose is meant is the power developed at given revolutions and given slip. As the power varies with pitch, diameter, shape, area, slip, efficiency, etc., it is readily seen that no rational answer can be given. We can, however, determine the thrust de-

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veloped by any given propeller, by means of model experiments, but to deduce a formula which will answer all cases is entirely beyond the naval architect to-day. I hope this clearly points out to the correspondent the impossibility at the present time of giving any rules as asked. B. A. SINN.

Additional Details of the Turbinia.

In regard to the torpedo boat Turbinia, articles on which I read with great interest in recent issues of your publication, there are a few points on which no information is given. For instance, you do not tell how the boat is driven astern, nor can she be run at low speeds economically, nor whether the type of motor is applicable to bigger vessels. If possible, I would like to get some information on these points.
S. J. MCNULTY.

(The queries put by our correspondent are best answered by the statements of the inventor, the Hon. Charles Parsons, made at the Institution of Naval Architects, London, in reply to queries put in the discussion which followed the reading of his original paper. How far the speed of the Turbinia could be reduced was a question which could not be answered in a word, said Mr. Parsons, but in ships of larger beam it would be certainly possible to make some reduction in the speed; in fact, the number could be lessened in direct proportion as the diameter of the turbine was increased. Down to 15 knots screws could be driven direct; below that gearing would have to be used, and then the turbine would be applicable to all classes of ships. He looked with distrust on gearing; the small gearing might be made to work, but the application of large geared wheels was a questionable device. The steam pressure could be as high as the boiler would give. It was quite possible to use superheated steam; the difficulty was in getting it. If the superheater were put in the intake, the temperature of which varied widely, according to the state of the fire, etc., or from combustion taking place there, the amount of superheat would also vary greatly. The chief advantage in using the turbine was that by compounding the steam could be expanded down to a lower pressure than ordinarily used; he was able to work down to 1 lb. final pressure, and at the same time could work with very high initial pressure. That gave a very wide range of expansion and consequent economy. If he were to work up to 300 lbs. pressure he would obtain still better results. The boat was driven in a sternward direction by means of a reverse turbine on one of the shafts; the steam was shut off from the ordinary turbine and turned on to the reversing turbine. With regard to steaming at low speeds, there was no difficulty; the engine was small and less steam was put into it. They could go at 11 1-2 knots with 15 lbs. pressure absolute, and could run down to any speed desirable. He had not yet been able to test the most economical speed of steaming. He had been asked if the steam had any cutting action on the blades, to which he would reply there was no such action. By compounding, the difference in pressure was small in any one element of the motor, and the velocity was therefore low; the only deterioration arose from wear, but the clearances were sufficient to put any difficulty from this cause beyond the reach of probability. The engines would develop up to 3,000 horse power without distress. The diameter of the propellers was 18 in. He found that cavitation began when the pressure on the blades of the propeller exceeded 11 1-4 lbs. He used normal screws slightly inclined, and had not gone into the refinement of increasing pitch in any one propeller, or in the propellers relatively to each other. The shafts were slightly inclined, so that the after screws worked partly in the wake of those in front of them, and partly in fresh water.—ED.)

An immense floating dock built by C. S. Swan and Hunter, Wallsend, England, for the Spanish Government, was towed to Havana by the S.S. Ruapehu. The dock is capable of lifting a dead weight of 10,000 tons, and is 400 ft. long. Very large mercantile vessels can be raised on it. The general dimensions are: Length over all, 450 ft.; width between alters, 82 ft.; extreme width, 109 ft.; depth over side, 27 ft. 6 in. The draught of water when so immersed is 42 ft. 6 in. and the free board 4 ft. 2 in. The material used in construction is mild steel. Structurally, the dock is composed of pontoons, which form the body of the dock and provide the necessary buoyancy, the sides which regulate the raising and lowering of the dock and give it stability, and the movable gates or caissons used when it is necessary to augment the lifting power. There are five pontoons, each 11 ft. 8 in. deep and 85 ft. broad, and the aggregate length is 450 ft. The middle pontoons are rectangular in shape and the end ones are finished off to a point. The motive power for the pumping machinery is electricity, and to raise the dock only requires 2 1-2 hours. The contract for the dock was signed last December and the first plate laid in March.

EDUCATIONAL.

ELECTRICITY ON BOARD SHIP, PRINCIPLES AND PRACTICE.—IV.

BY WM. BAXTER, JR.

In the last article it was shown that the pulsating current generated by the rotation of one loop in a magnetic field could be improved upon in point of steadiness by combining the currents generated by two, three, or more loops. The figures presented showed how this evening is due to the fact that in the case of two loops, when one is doing nothing the other is doing its utmost, therefore, the average effect of the two is more nearly constant. A little

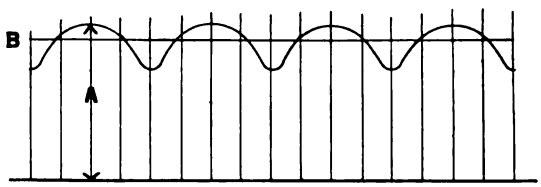

FIG. 18.

reflection will show that no matter how many loops there may be only one can be doing nothing, and only one can be doing its greatest work at the same time, and all the others will be developing a current intermediate between the maximum and zero. The curve Fig. 18 shows the amount of fluctuation in the current when two loops are used, and Fig. 19 the fluctuation for three loops. As will be seen, in both cases the current does not drop to zero as when one loop is used, but rises above and falls below a line B. This line represents the average value of the current, and is the equivalent of the average pressure line drawn on an indicator card of a steam engine.

The first impression in relation to the effect of combining a number of loops would be, possibly, that the effect being increased as many times as there are loops, the curve drawn to represent the resulting current, would be as many times as high as that representing one loop, as the number of loops used. That is, in Fig. 18 the distance A of the wave above the horizontal line would be twice as high as in Fig. 20, which represents a single loop current. On the same line of reasoning it would be assumed that the line

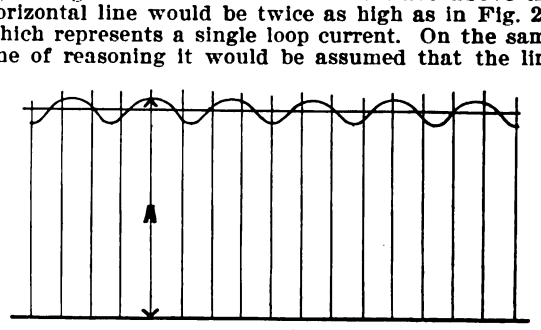

FIG. 19.

A in Fig. 19 would be three times as high. As a matter of fact such an impression would be entirely wrong for the simple reason that the top of the wave represents the maximum effect, and the result of combining a number of loops is not to multiply the maximum, but the average effect.

In Fig. 20, the line B represents the average effect of a single loop, and is obtained by constructing a parallelogram on the base E F, equal in area to the surface enclosed by this line and the curve. The method is exactly the same as that used to obtain the average pressure line in an indicator card, the peak of the curve which projects above the line enclosing an area equal to that of the two corners of the parallel-

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ogram that lap over the curve. In Fig. 21, which represents the current of two loops, the line B is of the same height as in Fig. 18, and is obtained by drawing one parallelogram on top of the other, brick-

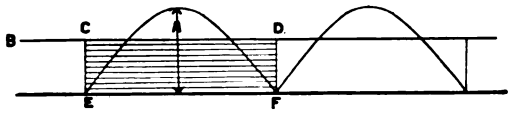

FIG. 20.

work fashion. That this construction is perfectly correct can be understood by noting that the two parallelograms are the equivalents of the waves N M of the two currents. Fig. 22 is constructed in the

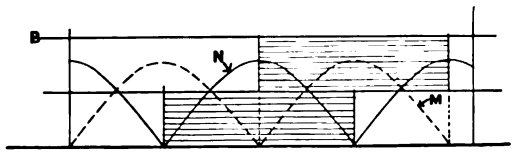

FIG. 21.

same manner, the three parallelograms being the equivalents of the waves N M P.

As will be seen from Figs. 18 and 19, the increase in uniformity of the current by the use of more than one loop is very decided, the number of waves is in-

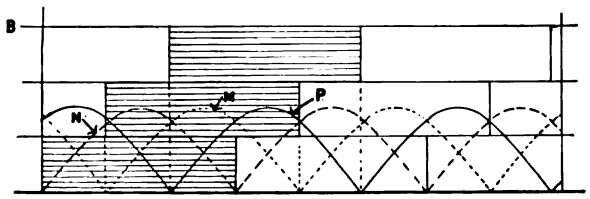

FIG. 22.

creased, and their height is reduced. It is easy to realize from this that by a comparatively small increase in the number of loops the waves can be made so short, and so small, that for all practical purposes the current will be perfectly uniform. In practice a number of loops are not used to accomplish the re-

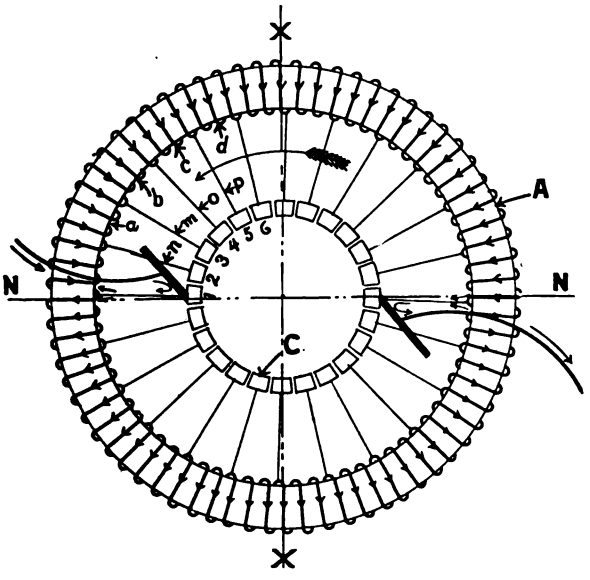

FIG. 23.

sult, because better mechanical results can be obtained by using another method, which can be explained by the aid of Fig. 23. The principle of this arrangement is the same as that explained in the foregoing, as will be seen presently; it is in fact simply a change in the constructive details.

Suppose you had ten loops rotating in the field, all equally spaced from each other, then, from what has been explained, it is evident that only one loop would be in a position where it would develop no current, and only one would be in a position to develop the maximum current. In all the others the currents would be intermediate between the two extremes. In the sides of the loops located above the diameter running at right angles with the lines of force, and which we have called the neutral line, the currents would flow in the same direction in space, and in the sides below this line the currents would run in the opposite direction. If each loop were connected with an independent commutator, and the brushes of these were connected with each other so that the B brush of one connected with the A brush of another, the currents generated would pass in succession through all the loops, and the electro motive force developed would be equal to the sum of all the electro motive forces of the ten loops at any particular instant of time. This arrangement, however, would require the use of ten commutators, which would be an objectionable complication. By resorting to the construction shown in Fig. 23, one commutator meets all the requirements. All the armatures of electric machines in general use are constructed upon this principle, although this may not appear to be the case when the form of the armature is considerably changed. The form shown in the figure is what is known as the Gramme ring. The core A of the armature is made of iron and in the shape of a ring; the wire is wound thereon in the same manner as rope on the circular fenders used on tug boats, as shown by the lines upon which the arrow heads are marked. The ends of the wire are joined so as to form an endless wire, and this is divided into sections, which are called coils, as indicated at *a b c d*. These divisions are effected by attaching wires as shown at *n m o p* to points of the wire wound upon the ring. The other end of these wires are connected with the blocks 2 3 4 5 of the circle C, which is the commutator. If a current flows into the brush located on the left side, as indicated by the arrows, it will pass from the block marked 1 to the wire on the ring, and as this wire is endless, it will present two paths leading to the brush on the right side of the commutator. One of these paths is by way of the wire wound on the lower half of tne ring, and the other by way of the wire on the upper half. From the direction in which the arrow heads on the wires point, it will be seen that the current in every turn above the line N N will flow toward the center, and in every turn below this line from the center. From this we can see that in the wire lying on the outside surface of the ring, the current will run up from the paper on the upper side, and down through the paper on the lower side. If the line N N is the neutral line of the magnetic field, the lines of force will be at right angles to it and parallel with line X X, and the direction of the current developed by the cutting of the wires on the outside of the ring through the magnetic field would be as stated above. As the brushes are held stationary, the segments 1 2 3, etc., of the commutator slide under them in succession, and thus the point at which the current enters the wire on the armature ring is shifted back coil by coil, as the armature revolves. In actual machines, the coils are wound separate and the ends of adjoining coils are connected with the wires that lead to the commutator segments.

By using a commutator of this type, it will be noticed that there are two points radically different from the arrangement with separate commutators previously explained. One of these is that the current divides at the brushes, and passes through the armature by two separate paths; the other is that the location of the brushes is shifted one-quarter of a

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circle. As to the first change, a little reflection will show that as the object is to keep the brushes in contact as near as possible, with the points of the wire on the line N N the only way to accomplish it is by cutting off the front and adding to the back of the wire as the ring rotates, and this can only be done by making the wire endless, so as to slip the connections back. But if the wire is endless, there must necessarily be two paths for the current. The position of the brushes is changed simply because the

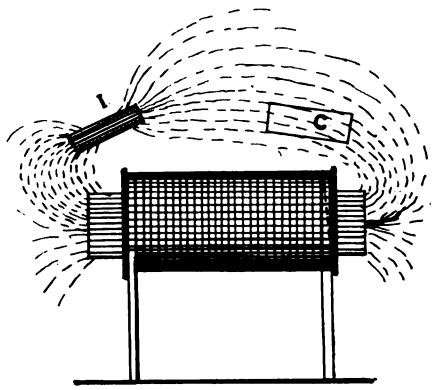

FIG. 25.

width of the segments is reduced from nearly one-half the circumference to a comparatively small fraction thereof, hence the dividing space when the brushes pass from one segment to the other is but a short distance away from the line N N, instead of ninety degrees, as is the case with a single loop.

If the armature ring A were not made of iron, the action of the machine would be very imperfect. From what has already been said, it will be understood that the lines of force would pass across from one side of the armature to the other in straight lines, and as all the loops of which the winding is composed

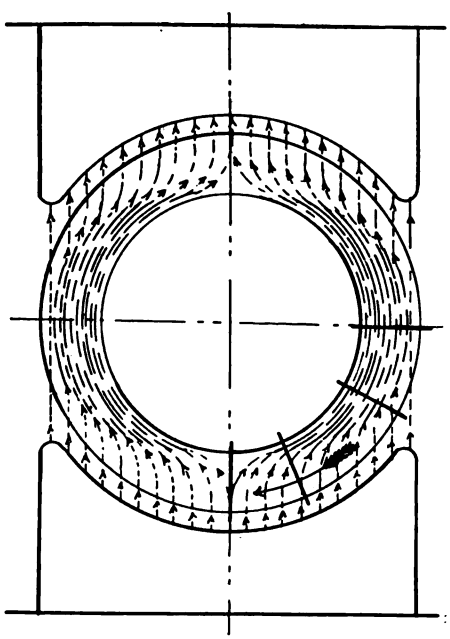

FIG. 24.

have both sides on the same side of the center of the shaft, both sides would have currents developed in them that would be in the same direction, in space, that is either up from the paper, or down through it. From this very fact the direction of these currents in the wire itself would be opposite, and therefore the current developed in the outer side of the loop would counteract that developed in the inner side, and the actual current would be the difference betwen these two. When the armature ring is made of iron the conditions are at once changed in the manner indicated in Fig. 24. As iron is a better conductor of magnetism than air, the effect of the ring is to shield the central space. Theoretically, a small portion of the lines of force would pass across the space inside of the ring, but in practice it has been demonstrated that their number is so small as to be unworthy of notice.

In order that electricity may flow along a wire it is necessary that the latter be insulated. If the wire on the ring in Fig. 23 were bare metal, in actual contact with the ring, only a small portion of the current would flow in it; the remainder would pass into the iron ring. Electricity does not follow a wire because it is its nature to run through a long and tortuous path, but because it cannot find a way to get out of the wire, the latter being covered at all points with material through which electricity cannot pass without great difficulty. All known materials are conductors of electricity, but they are divided into conductors and non-conductors, according to their degree of conductivity. Mica, glass and similar substances resist the passage of an electric current to such an extent that only extremely high electric motive forces can pierce them. Other materials, like copper, silver, etc., are such good conductors that the lowest E. M. F. will send a current through them.

Wires through which electric currents are conveyed are made of copper, because it is one of the best conductors. To prevent the current from escaping, it is covered with cotton, which is one of the very poor conductors. The cores of magnets, and other metallic parts of machines, are separated from the wire, and the parts in which the current flows, by means of paper, cloth, mica and other non-conductors, so as to prevent the escape of the current. These poor conductors are called insulators, but there is no known substance that is a perfect insulator of electricity.

There are many substances through which electricity passes with such difficulty, that for all practical purposes they may be regarded as perfect insulators, but there is no form of matter through which the lines of magnetic force will not act in a decidedly energetic manner. Different substances are classified as magnetic or non-magnetic, but this classification is based upon whether they can be made to show magnetic properties or not. A piece of iron placed near a magnet will itself become a magnet. If it is soft iron it will remain a magnet until removed from the vicinity of the magnet by which it is energized. If it is made of hardened steel it will retain its magnetism. A piece of copper placed near a magnet will not become magnetized. The reason for this difference can be understood from Fig. 25. The piece of iron I being a better conductor of magnetism that the surrounding air, concentrates the lines of force upon it, and therefore exhibits polarity just the same as the large magnet; but the copper C being no better conductor of magnetism than the air, does not concentrate the lines of force; hence, the magnetic field at its ends is no stronger than anywhere else. From the foregoing we may say that magnetic substances are those that are better conductors of lines of force than air, and non-magnetic substances, those that are poorer, or at the most no better conductors than air.

The steamer Juanita was launched by the Harlan & Hollingsworth Company in the presence of several thousand persons. She was built for the Merchants' and Miners' Transportation Company, and is 270 ft. long, 42 ft. wide, and 34 ft. deep. Her construction was remarkably speedy, only 4 months and 12 days having elapsed from the time the first frame was raised.

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HOME EXCHANGES.

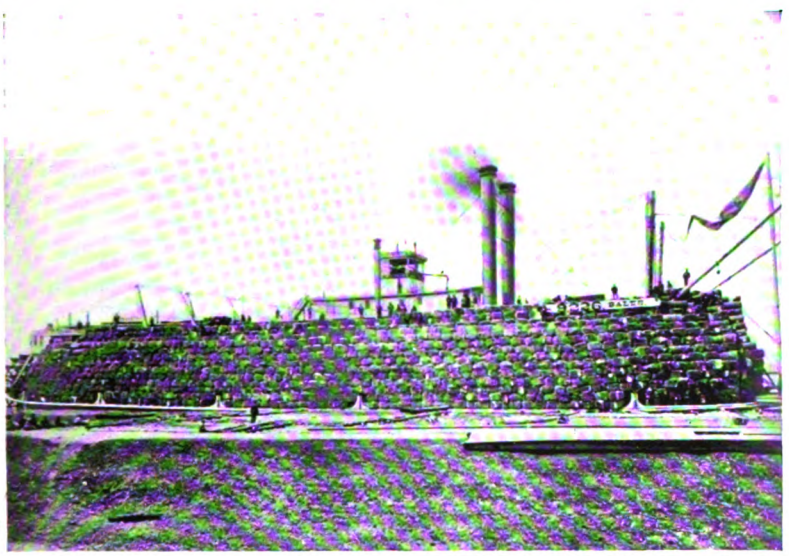
Steamboats on Western American Rivers.

The Ohio river, from Pittsburg to its mouth in the Mississippi, near Cairo, Ill., has a length of about one thousand miles. Its total drainage area is about two hundred and ten thousand square miles. The total population of the cities and towns situated immediately upon the banks of the Ohio and its principal tributaries is about two millions. Hence the importance of the stream as a highway of commerce is great.

During 1896 more than eight million tons of freight and more than five hundred thousand passengers were carried by boats. The freight consisted of coal, iron, manufactured products, and general merchandise, and its value exceeded $250,000,000.

The capital invested in boats is, approximately, $8,500,000. The total amount expended on the improvement of the Ohio for the last seventy years is not more than 2 1-2 per cent. of the value of the freight carried on the river in a single year.

The annual shipments down the Ohio by steamer average more than 7,000,000 tons, and the number of passengers averages more than 1,600,000. Coal shipments are not included in this estimate. Shipments of logs, lumber, and railroad ties towed and rafted amount to 1,000,000 tons. Of corn, oats, hay, apples, potatoes, cabbages, cider, tan bark, hoop poles, lime, etc., sent by flat-boats there are 50,000 tons. Of glass and stoneware, dry goods, groceries, oil, hides, pelts, oil barrels, scrap iron, old rope, etc., sent by trading boats, there are 15,000 tons.



STEAMER HENRY FRANK, WITH 9,226 BALES AND 250 TONS CARGO ABOARD.

The New Orleans was the first steam vessel west of the Alleghanies and was built by Fulton. It was 138 ft. long, and of about 300 tons capacity. This steamer had a stern wheel and two masts—for even Fulton thought sails absolutely indispensable—and one engine. She continued her packet trips between Natchez and New Orleans until July, 1814, when she struck a snag near Baton Rouge and was wrecked. Her average speed was about three miles an hour up stream. She made several trips to Natchez before the merchants would assume the risk of shipping freight on her, perferring the old slow barges or keel boats.

In 1816 a steamer—the first double-decker—was built at Wheeling by Capt. H. M. Shreve. Shreve used French's engines, but placed them in a horizontal position, and gave the vibration to the pitman. He added his great invention, the cam cut-off, and put flues in his boilers, by which three-fifths of the fuel was saved. He named the boat Washington. Leaving Louisville March 12, 1817, she went to New Orleans, discharged and reloaded, and, returning, reached the foot of the Falls in forty-one days. The ascending voyage was made in twenty-five days, including stoppages.

Several boats of queer design were built in the years following, among them the steamer Bazabeel Wells, the greatest curiosity of the age. She was built in 1819, with an engine from a flour mill at Steubenville, boiler from another mill at Pittsburg, and a chimney of brick. The first landing she made knocked down her chimney, whereupon she was provided with a sheet-iron smoke-stack.

In twenty years the genius of the United States made such strides in navigation and transportation that the waterways became almost exclusively the routes of travel. About this time the great system of national highways or turnpikes was introduced and rapidly extended, but the river transit had grown to be so restful, agreeable, and comfortable, and withal so speedy, that everybody who traveled went by steamboat.

From this time until the early fifties steamboats were built in great numbers; the improvement was continuous, and many of the finest steamers ever constructed were built and placed in commission. The decade of 1850-60 was the golden age for steamboats. Daily lines of fast mail steamers were inaugurated.

In the early fifties the Pittsburg and Cincinnati Packet Line consisted of a fleet of fast side-wheel steamers, finely modeled, with big power, but of limited freight capacity, comprising the Buckeye State, Allegheny, Brilliant, Monongahela, Crystal Palace, Pennsylvania, and Pittsburg; while the opposing boats, known as the "Wheeling & Louisville Union," consisted of similar crafts, named the Alvin Adams, David White, Thos. Swan, Baltimore, Falls City, Virginia, and City of Wheeling. To illustrate we give the dimensions of several of these fast clippers—all side wheelers:

The Buckeye State, built at Pittsburg: length, 285 ft.; beam, 30 ft.; floor, 28 ft.; depth of hold, 6 1-2 ft.; capacity, 548 tons; five double-flue 42-in. boilers, 30 ft. long; 30-in. cylinders; stroke, 8 ft. The fastest trip from Cincinnati to Pittsburg credited to the Pittsburg line in 1851 was made by the Buckeye State—490 miles in 40 hours.

The Pittsburg, built at Shousetown, Pa., in 1851: length, 295 ft.; beam, 30 ft.; floor, 29 ft.; hold, 6 1-2 ft.; capacity, 650 tons; five double-flue 42-in. boilers, 30 ft. long; 31 1-2 in. cylinders; stroke, 8 ft. Value, $30,000.

The Alvin Adams, built at McKeesport, Pa., in 1853: length, 281 ft.; beam, 35 1-2 ft.; floor, 33 ft.; hold, 6 2-3 ft.; capacity, 750 tons; six double-flue 42 in. boilers, 28 ft. long; 29 1-2 in. cylinders; stroke, 9 ft. Value, $50,500.

The great low-pressure Jacob Strader, of the Cincinnati & Louisville Mail Line, built at Cincinnati in 1853: length, 332 ft.; beam, 37 ft.; floor, 32 ft.; hold, 7 1-2 ft.; two 16-flue boilers 11 ft. in dia. and 38 ft. long; two poppet-valve engines 5 ft. in dia.; stroke, 10 ft. Value, $120,000. Her boilers, not working well in the muddy water of the Ohio river, were removed, and the old-fashioned double-flue boilers were put in their place. The Strader has the fastest time on record from Louisville to Madison—43 miles in 3 hours and 12 minutes. The Telegraph, of the same line, having made the fastest time from Louisville to Cincinnati the same year—9 hours and 52 minutes

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—the Strader was not permitted to beat it, though she could have done so easily. The only steamer that claims to have beaten the Telegraph's time from Louisville to Cincinnati is the new City of Louisville, of the same company, which made the run from port to port in 1896 in 9 hours and 40 minutes.

The fastest trips from New Orleans to Cincinnati—1,513 miles—have been made by the following boats, all side-wheel: 1843, Duke of Orleans, 5 days, 18 hours; 1877, Chas. Morgan, 6 days, 11 hours, making 42 landings and losing 3 1-2 hours passing through the Louisville canal; 1877, Thompson Dean, 6 days, 19 hours, losing 14 hours in the canal and 17 hours at way-landings; 1881, R. R. Springer, 5 days, 12 hours, 45 minutes, running time; 1881, Will S. Hays, 6 days, 17 hours, 10 minutes, port to port, having made 51 landings, and met with other delays.

The Dean and Hays had 30 in. cylinders, with a stroke of 10 ft. The Duke of Orleans, like all boats that passed through the old short Louisville canal, was only 172 ft. long.

With the present enlarged canal, the boats now in use are longer and of lighter draft, with more than double the capacity, enabling the Upper Ohio to compete with the Lower Ohio and Mississippi steamers.

For general freight business, economy, passenger-comfort, and speed, the stern-wheel is fast taking the place of the more expensive side-wheel steamer on the Ohio and Mississippi and their tributaries. They make the same time in all packet trades, and, in comparison with the old side-wheel packets, carry twice the cargo with less power.

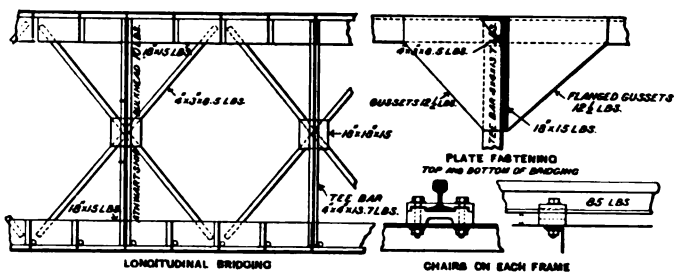
The rapid decline in steamboating on the western American rivers is attributed to the rapid increase in railroads and the diminution of the water supply. The government has awakened to the fact that the waterways must be cherished, and the navigation of prominent streams made continuous and permanent. This is now being done by the construction of the chanoine dam, which can be raised or lowered in a few hours, thus not interfering with the navigation when nature supplies the volume of water, but furnishing a guarantee of steamboat transit, except when ice prevails. Last year Congress appropriated more than $11,000,000 for the maintenance and construction of these betterments. The bill was vetoed by the President, but passed over his head. This improvement established, the Ohio valley must become the coal-producing center of the world. England's coal supply is limited. The almost limitless coal fields of Pennsylvania, West Virginia, Ohio, and Kentucky, being adapted for rehandling and for foreign shipment, can supply the demands of the world for ages.

With the building of the canal from Pittsburg to the Lakes, the locking and damming of the Ohio river, and the construction of the Nicaragua canal, Pittsburg coal can be sold in San Francisco at $4 to $5 per ton, where other and inferior coal is now selling at $7 to $8. American coal could be sold at Callao, on the west coast of South America, at $5 per ton, where it now commands $15. In Valparaiso, where other nations control the coal trade, United States coal could be furnished at $5 to $6, while now the price varies from $12 to $13.

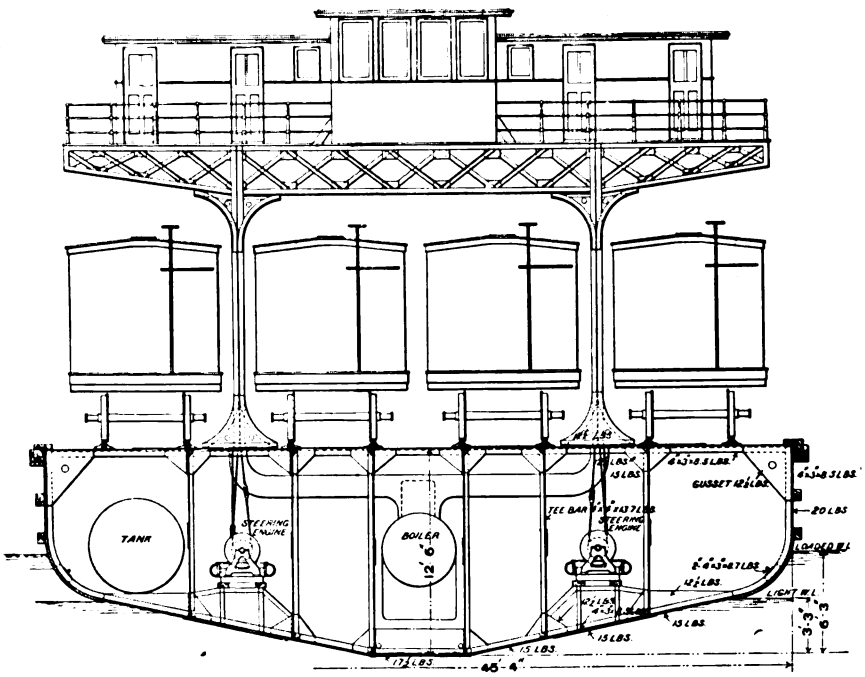
Cons. D. Millar, in the August number of the Engineering Magazine, to which we are indebted also for the use of the illustration.

Car Float for N. Y., Phila. & Norfolk R. R.

A large car float is being built by the Crescent Shipbuilding Company at Elizabethport, N. J., for the New York, Philadelphia & Norfolk Railroad, and through the courtesy of Theo. N. Ely, Chief of Motive Power of the Pennsylvania Railroad, we are enabled to illustrate and describe it. The float is to be one of the largest ever built and will be known as barge No. 5. It is to be used for the transfer of freight cars between Cape Charles and Norfolk, Va. The length is 340 ft., beam over all is 47 ft. 3 in., beam over hull 45 ft. 4 in., and the total depth 12 ft. 6 in. The draft when light will be 3 ft. 3 in., and when loaded 6 ft. 3 in. There are four tracks, which will hold 28 cars, and the equipment and appointments of the boat will be complete and well arranged.



SYSTEM OF LONGITUDINAL BRACING OF CAR FLOAT.



TRANSVERSE SECTION OF CAR FLOAT FOR N. Y., PHILA. AND NORFOLK R. R.

The hull is divided into 18 water-tight compartments by transverse steel bulkheads spaced 20 ft. apart. A 6-in. pipe, which runs the entire length of the float, is provided with valves in each compartment for trimming the float with water ballast. The midship compartment contains the boiler, pumps and steering engines.

The float is being built to drawings prepared by the railroad company and the details have been admira-

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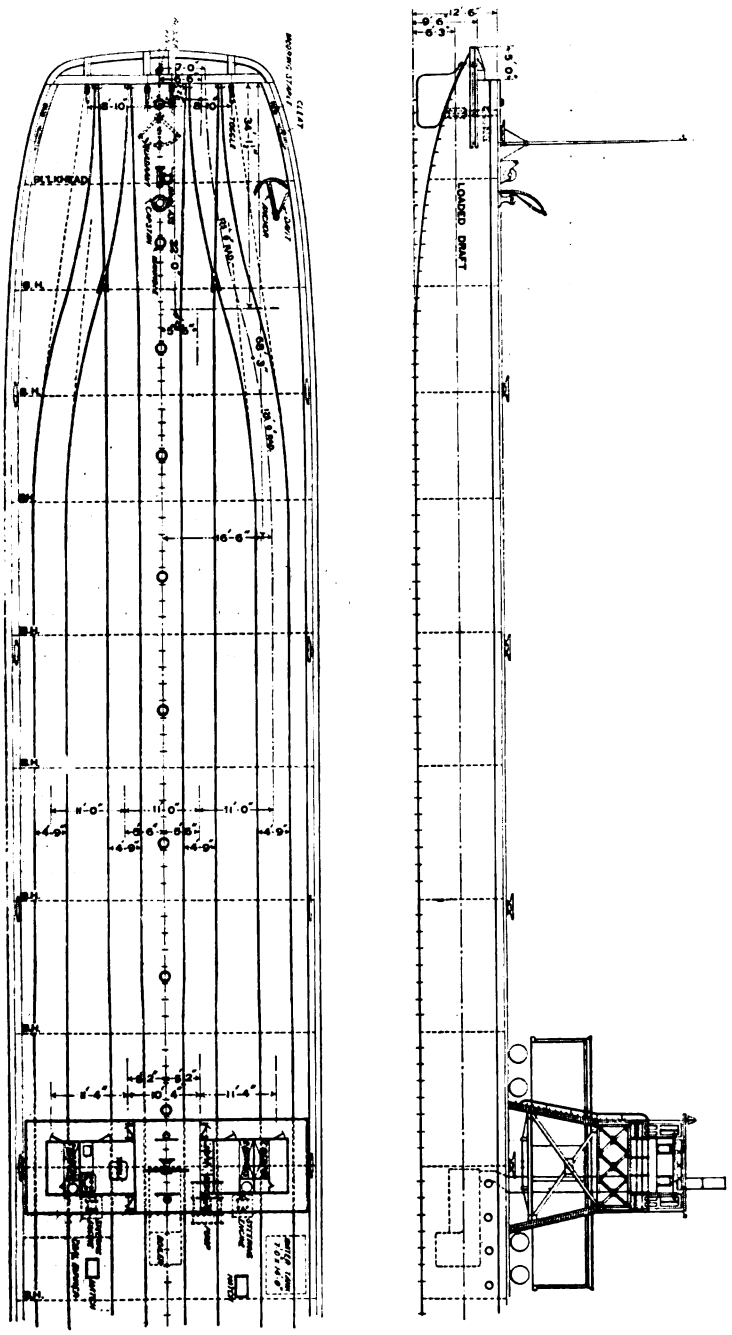
bly worked out. The boat has no shear and the deck plating is flush, the seams being made on joint plates upon the under side. The bottom plating is of the usual form with out and in strakes. The keel plate is 7-16 in. thick and is 6 ft. wide, being straight. The plates in transverse section are straight from the keel plate to the bilge, where they turn on a radius of 4 ft., and the sides from there to the deck are vertical, which is not an unusal construction. The bottom plates on both sides of the keel plate are 3-8 in. thick, and 5-16 in. plates are used for the deck. The frames are placed 2 ft. 6 in. apart at the center and 2 ft. at the ends of the boat. They are of angles 4 by 3 in. of 8 1-2 lbs. section. The deck beams are also of the same sized angles and they are gusseted to the frames and to the longitudinal bracing. This longitudinal bracing consists of six trusses which run the entire length of the boat and are virtually keelsons extending from the bottom plating to the deck. The chords of the trusses are 15-lb. plates, 18 in. wide, and the bracing between them is made of 4 by 3 in. 8 1-2 lb. angles. The verticals or struts are T-sections, 4 by 4 in. of 8 1-2 lbs. section. The struts are omitted at the bulkheads and two 4 by 3 in. angles with the 5-16 in. bulkhead plate between them are substituted therefor. The bulkhead plates are joined to the bottom plating by 3 by 3 in. double angles and gusset plates are used in the deck connections. The truss plates are continuous and gussets are used at each frame. The keel plate is braced by vertical transverse plates to which the frames are riveted.



CAR FLOAT FOR NEW YORK, PHILADELPHIA AND NORFOLK RAILROAD, BUILT BY CRESCENT SHIPBUILDING CO.

The deckhouse is carried on a large bridge supported by four posts of channels which have ample gusset bracing at the deck and bridge. In the deckhouse are the pilot-house and cabins for the crew. The float has two rudders, one at each end, which may be worked by two independent Williamson steam-steerers, or by independent hand gear. The rudders are made on spider frames and have no bottom support. All of the machinery is located in the compartment under the bridge. Steam is supplied by a small Scotch boiler 5 ft. 6 in. dia., by 7 ft. long, and 3,500 gallons of fresh water may be carried in a cylindrical tank in this compartment. The pump for trimming the float and for fire purposes is of the Snow duplex pattern, with 8 1-2 by 10 in. cylinders. The 6 in. pipe already referred to connects this pump with all of the compartments, and communication either for emptying or filling them may be made by a valve controlled by a hand-wheel at the deck over each compartment. A Providence brake windlass and a Providence hand-power capstan are provided at each end of the float.

The courtesy of Lewis Nixon, of the Crescent Ship Building Company, and of Theo. N. Ely and H. S. Hayward, of the Pennsylvania Railroad, are acknowledged.

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The Goodrich Co.'s steel twin screw passenger steamship Virginia has finished her season's running between Chicago and Milwaukee, says the Marine Record. The passenger business has been so prosperous during the season that the company intends to spend over $100,000 in remodeling and improving some of its steamers. The most important change will be in the steamer Virginia. She is to be increased in length 50 ft. or 60 ft. and will receive finer lines forward. Two additional boilers will be given the steamer. With the change in her bow and the extra supply of steam it is anticipated that the Virginia will make the run between Chicago and Milwaukee in four hours. The estimated cost of the alterations is $75,000.

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NEW PUBLICATIONS.

THEORETICAL AND PRACTICAL GRAPHICS. By Prof. Frederick N. Willson, M. E., Professor of Mechanics, Princeton University. Princeton University Press. pp. 286. With many illustrations.

This is the best contribution yet given on the subject of Descriptive Geometry and Mechanics. The work is primarily for students, but the contents are of such a practical character as to make it a most valued aid to the practical draughtsman and engineer. A thorough knowledge of Descriptive Geometry is the basis in the making of drawings for machinery, for arch work, and for both building and ship construction. Under its method of Projection the stresses in bridges and roof trusses or other engineering construction are graphically determined. This evinces the high industrial utility of the study. In Prof. Willson's work the old method of Projection, or Monge's First Angle Method, is fully explained, in so far as that system is now used, but especial care has been given to an exposition of the Third Angle Method, which is the one chiefly pursued by the best trained constructors of the day. Engineers and draughtsmen will find valued knowledge in the treatment of Gearing, Slide Valves, Screws, Development of Surfaces, and Link Motion Curves. The chapter on the intersection of surfaces will be found of great service in the construction of shafting and piping. Under Warped Surfaces there is given a very lucid and valuable arrangement of a subject that is so useful in treating problems of screws and gearings. Map and Chart Projection is treated in a general way for the instruction of the student. The subject being so broad would require a large-sized work for its full exemplification, but such matter as is given is most useful and fully complies with the requirements of the manual as a text book. In nomenclature he has performed a lasting good for the study. Although the subject has received its greatest attention from other than English writers, yet it seems left to Prof. Willson to unify and give the subject fitting and explicit nomenclature. That portion of the book devoted to Sketching, Lettering, Dimensioning and Conventional Representation of Materials, Use of Instruments, Working Drawings, and similar topics is most complete and of aid to the student. The "make up" of the book is suggestive to publishers of technical works to pattern by it. A well selected paper, a very readable dress of type, and over four hundred illustrations, reproduced by the very best of modern means, constitute no small value of the work. There is no redundant matter given by Prof. Willson. He not only understands his subject, but the plan of the work shows evidence of great care in its arrangement and groupings. His method of exposition is much to be commended. Besides selecting solutions by the best recognized methods he has also given many direct methods of solution of his own. Problems are demonstrated connectedly and clearly and then sensibly applied to constructing or draughting work. The merit of the work justifies the hope that further works by Prof. Willson may follow.

A pamphlet was issued by Assistant Secretary of the Navy Theodore Roosevelt from the Government printing office, entitled "The Naval Policy of America as Outlined in Messages of the Presidents of the United States, from the Beginning to the Present Day." In a preface Mr. Roosevelt explains that the quotations do not at all include all the references to the navy by Presidents of the United States, the selection omitting references to the work of the navy during war times and touching rather upon the necessity for an efficient navy. The most terse of all the many utterances is that of President John Adams, who just 100 years ago said: "Naval power is the natural defense of the United States." The little pamphlet is of interest and is sure to have a wide-spread effect.

Klondike Edition, Self Help, No. 5, is the title of an extremely interesting pamphlet issued by the Colliery Engineer Co., proprietors of the Correspondence Schools, Scranton, Pa. It is a hand-book compressed into the space of 8 pages, 9 in. by 12 in., which contains about all any one wants to know about the Northwestern gold fields. There is a general chapter on the Yukon gold fields, information as to the best ways of reaching there, the necessary outfit to take along, also a description of life in the gold country, hints on how to preserve health there, and practical points on "how to find gold." There are good reproductions of views of the country and a map of the Yukon region. Although the Klondike is, for most persons who have serious work to do, a very desirable place to keep away from, this pamphlet is well worth the price of a postal card, addressed to the publishers, for the information it contains.

Advices from England report the placing of a contract for a new and enlarged Turbinia with W. Hawthorn, Leslie & Co., of the east coast.

A report was circulated that the old Inman liner City of Chester would be purchased by an English syndicate and sent to Alaska with an expedition bound for the Klondike gold fields.

The documented merchant marine of the United States on June 30 last included 22,633 vessels of 4,769,020 gross tons. To this the Atlantic and Gulf coasts contribute 2,647,296 tons, and the Great Lakes 1,410,103 tons. The steam tonnage amounted to 6,599 vessels of 2,358,558 gross tons.

Thomas McKean, of Philadelphia, one of the directors of the Philadelphia and Reading Railway Co., placed an order with the Cramps for a steel yacht, to be launched and completed by April next. The new yacht will be 213 ft. long and 23 ft. 3 in. beam, with a sea speed of about 16 knots.

The Delaware River Iron Shipbuilding and Engine Co. booked an order for a sister ship to the John Englis of the Maine Steamship Co. The new vessel will have additional passenger room and will carry 1,400 tons cargo and 200 tons coal on a mean draught of 15 ft. 9 in., and will be able to maintain a sea speed of 16 knots.

SELECTED PATENTS.

589,259—WATER-GAGE. *Joseph Hopkinson and John Lowis, Huddersfield, England, assignors to J. Hopkinson & Co., Limited, same place. Filed Dec. 19, 1896.*

In a safety water-gage the combination of steam and water arms connected by a gage-glass C and a tube D, a try-cock connected to the water-arm, a chamber B' below the tube D, a ball-valve in the chamber, and thoroughfares forming communications between the chamber and the boiler. In a safety water-gage the combination of a steam-arm A and water-arm B connected by a gage-glass C and a tube D, a try-cock B^4 connected to the water-arm, a chamber B' in the water-arm below the tube D, the chamber communicating with the boiler, the tube D, the gage-glass C and the try-cock B^4, a ball E in the chamber B' adapted to close the passage B^2 leading to the gage-glass, the top of said ball when resting on the floor of the chamber being below the level of the passage Bx leading to the boiler, and a ball G in the steam-arm adapted to close the passage A' leading to the gage-glass.

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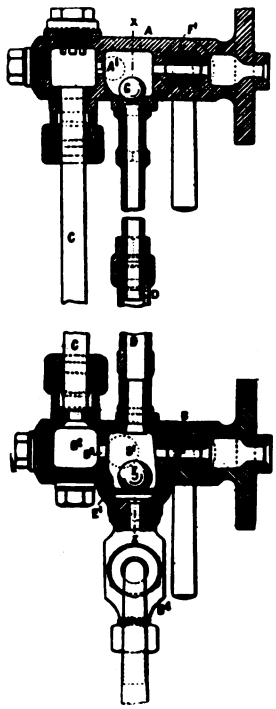
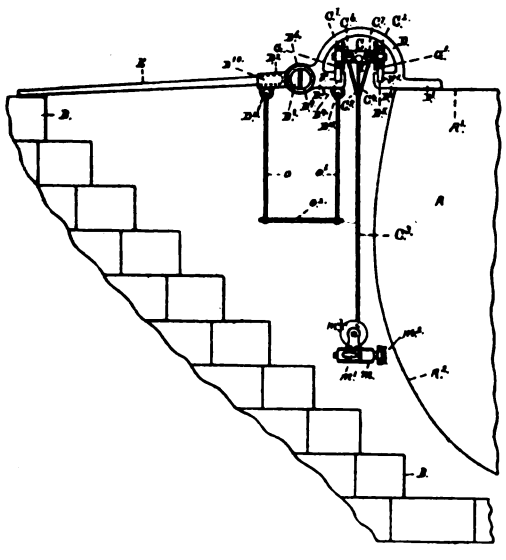
588,933—ELECTRICALLY-OPERATED SHIP-CLEANING DEVICE. *Eddy T. Thomas, New York, N. Y. Filed Apr. 21, 1896.*

Claim.—The arched frame D, supporting the electric conductors G and G', in combination with the truck



HOPKINSON AND LOWIS WATER-GAGE.

C, provided with the wheels C' and C², for holding the portable suspended motor M, and tools operated



THOMAS SHIP-CLEANING APPARATUS.

by motor. The arched frame D, supporting the joist F, the electric conductors G and G' forming a track for the truck C to run on, in combination with the truck C. The frame D, having adjustable arm D⁹, pole E, staples D¹¹ and D¹², to support the ropes O O', and scaffolding O², for the purpose described.

CATALOGUES.

Very neat folders lithographed in color are being distributed by the Joseph Dixon Crucible Co., Jersey City, N. J., giving detailed information regarding the well-known pencils and crayons made by this company. This folder will be of much use to draughtsmen and other users of pencils who wish to know the various degrees and qualities.

A catalogue has reached us from C. E. Parker, Orange, Texas, descriptive of the Parker safety water tube boiler. Several cuts of the boiler are given, illustrating fully its arrangement and general design, and sufficient reading matter accompanies the cuts to give a comprehensive idea of the special features of this boiler. It has been approved by the Government Supervising Inspector, and is allowed to carry a working pressure of from 200 to 300 lbs.

Owing to the changes in the tariff in the recent Dingley bill the Keuffel & Esser Co., New York, has issued a revised price list. Every user of draughtsmen's instruments and supplies should have a copy of this list, as it is up to date in every respect, and as this list is intended to supplement the general catalogue, it should be used in connection with that. Copies of the catalogue as well as this revised list can be had upon application to the company.

An exceedingly good catalogue is being distributed by the National Lubricator Co., 107 Montgomery street, Albany, N. Y. It is of convenient size to carry in the pocket and is well printed, being in two colors, red and black. Several pictures of the various types of lubricators are given, showing their general design, and their operation is fully explained. Photographs of stationary engines are given, showing the application of the lubricator, and a large beam engine is also shown.

An extremely fine specimen of press work is catalogue No. 96 on steel plate fans just issued by the B. F. Sturtevant Co., Boston, Mass. It comprises 124 pages, 6 1-2 by 9 in size, is printed on coated paper and is very fully illustrated with the various types of fans manufactured by this company. Everybody interested in the subject of ventilation or forced draught, or in other uses, where a blower could be used, will find a great deal of information in this catalogue, as it covers the subject very completely and contains several pages of tables which are valuable for reference.

Users of varnish on marine work will appreciate the catalogue sent to all inquirers by the David B. Crockett Co., Bridgeport, Conn., which gives considerable information regarding the finishing of wood, especially when exposed to the elements, as on vessels, yachts, etc., and in order to emphasize the quality of the varnishes and other wood preservatives manufactured by this company each catalogue is accompanied by a piece of wood finished in the ordinary way. This gives opportunity to test the quality of this work and find out the weather-proof qualities of the varnish.

A copy of the very handsome catalogue published by the Racine Yacht and Boat Works, Racine Junction, Wis., is just received. It is 6 1-2 in. by 10 in. in size, and comprises over 60 very fully illustrated pages devoted to everything connected with yacht and boat work. It illustrates various types of rowboats, combined row and sail boats, dingheys and yacht tenders, schooner and sloop yachts, both cutter and centerboard; canoes of all kinds, racing shells, steam yachts, electric, gas, and steam launches; in short, everything that is necessary for boats and yachts. Every man interested in the subject of designing and constructing boats will find this catalogue particularly valuable.

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General Catalogue No. 12, just received from the Electric Appliance Co., 242 Madison street, Chicago, Ill., is a volume of astonishing size and elaborate completeness. It is handsomely bound in red cloth, and comprises 568 pages. Everything that the practical electrician could have use for is fully illustrated and described. Some idea of its completeness can be had when it is stated that the index alone covers 12 pages of two columns each. Every man who has the purchasing of electrical supplies will find it invaluable to have such a complete catalogue as this at hand. Many articles of special design for marine uses will be found fully illustrated and described.

That good printing and press work are a profitable investment is evidently the policy of the Peerless Rubber Mfg. Co., 16 Warren street, New York, judging from Catalogue No. 24, just received. It comprises 120 pages, nearly every one of which contains at least one illustration, and many pages are printed in two colors, showing graphically the appearance of many of the red rubber products of this company. Rainbow packing, of course, occupies the first position, and is very fully described and illustrated, and complimented by letters which have been received from users of it. Other subjects which receive full attention are Rainbow gaskets, various rod and other packings, pump valves, and such manufactures of rubber as hose pipe, buckets, belting, tubing, cement, fire hose, matting, etc. The cover of the catalogue is a rich shade of dark green and the lettering is of gold, giving a very fine effect.

The 1897 catalogue now being distributed by the Boston & Lockport Block Co., Boston, Mass., is of very convenient size, being small enough to put in the pocket, and besides is very complete and has many illustrated pages. Among the special features worthy of more than usual mention in this catalogue are the oval edge yacht blocks which are brass screw riveted, and in other ways up to date so far as strength and economy of operation are concerned. There are many tables and other important information regarding blocks, trucks, pumps and other specialties required in fitting and operating yachts and steam vessels, each subject being illustrated and described. A test recently made at the Watertown arsenal shows that the blocks of this company are of unusual strength. The results of this test are fully given on page 105, and are well worth the consideration of every user of blocks. An unusual feature of this catalogue is the printing of a star in red on each page. This is the trade-mark of the company.

BUSINESS NOTES.

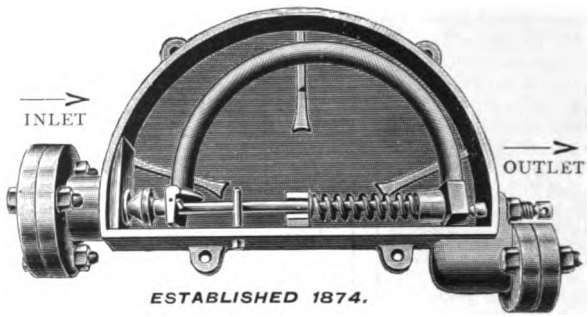
REPAIRS TO TUGS.—The Lockwood Mfg. Co., Boston, Mass., has two tugs undergoing extensive repairs at its yards. Boilers and engines are being overhauled and other improvements made.

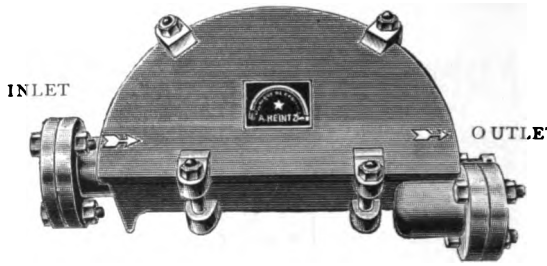
A GOOD CLEANSER FOR ENGINEERS.—The India Alkali Works, 75 Broad street, Boston, is meeting with much success among engineers in selling Savogran, a cleanser made especially for the removal of oil and grease.

MARKED ECONOMY.—Regarding the economy resulting from the use of Serve's patent ribbed steel boiler tubes, we have received from Chas. W. Whitney, 11 Broadway, New York, a report of tests made in the Fall River boat Priscilla, showing an economy of not less than 10 per cent. Copies of this report can be had by applying for them.

HIGH PRESSURE STEAM VALVES.—The Coldwell-Wilcox Co., Newburg, N. Y., is getting out steam valves and other specialties where high pressures are required, which will interest every engineer. The catalogue regarding these specialties can be had upon application to the company. This catalogue also illustrates expansion joints, separators, oil filters and other goods.

A Marine Trap That Never Fails.





The Heintz Steam Saver

*****—

has been adopted by the Marines of Belgium, France, Russia and Germany and is now attracting universal attention amongst the fraternity in the United States, where it is now being introduced.

WHY

it does so can be readily understood by noting the reasons. It is the SIMPLEST trap in existence. Has no levers, floats, air valves or grinding joints to wear out. Works in ANY POSITION at any pressure up to 200 pounds. "Pitch" or "list" on the ship has no influence on its results.

ELEVATES the water anywhere.

CONSUMES NO STEAM.

DOES NOT BACK UP.

NO INSIDE PRESSURE.

Easily and quickly opened.

LASTS A LIFE-TIME.

Chief Engineer of the International Steamship Co. says:—
"I like the trap better than any I have ever used."
"A. F. BREMNER."

THE CHEAPEST as well as THE BEST.

A postal card is enough to learn all about it.

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